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JOINT CONSULTATION IN MANAGEMENT

WHEN the Committee on Industrial Productivity, appointed in December 1947, formed its Panel on the Human Factors affecting Industrial Productivity, under the chairmanship of Sir George Schuster, one of the first subjects to which the Panel turned its attention was current managerial practice. The soundness of this decision has been confirmed by the experience and reports of the productivity teams which have since been sent by the Anglo-American Council on Productivity to study American practice in various industries. Two of the outstanding lessons to be learned from the experience of these teams are the extent to which efficient management sets the pace of productivity and the importance of dealing with those engaged in industry as human beings whether at the level of the operative, the foreman, the technologist or the manager.

Two extensive surveys in this field were planned by the Panel and were undertaken under its sponsorship by the National Institute of Industrial Psychology: one was into the status, selection and training of foremen and the second was into methods of joint consultation. Both inquiries were designed to present a picture of current practice in the whole range of industry and to relate the nature and the effectiveness of the methods in use to the size, location, internal structure and history of the firms approached. A report on the first project has already been published. That on the second, which occupied three years, during which 189 factories were visited and information received from many others, has now appeared*, appropriately enough when the Acton Society Trust has issued a corresponding but slighter study of joint consultation in the nationalized industries, which were excluded from the inquiry initiated by the Panel on Human Factors†.

The report seeks to elucidate the factors associated with successful joint consultation, and after defining the scope of the inquiry, the purposes of joint consultation and the criteria of success, analyses, in successive sections, psychological conditions and their effect, the bearing of technical and economic factors, the organization and finally the achievements of joint consultation. In the last two chapters of the book joint consultation is discussed first from the point of view of the worker in broad terms and then from that of the manager, both as leader and as employer. There is also a foreword by Sir George Schuster.

It is by no means clear to whom the book is addressed, and probably something much more concise would have been surer of reaching the average factory executive, trade union official or works council representative, particularly if the details were made accessible to those sufficiently interested. Much of the material or evidence here presented is indeed of general interest; but the task of exposition seems

* Joint Consultation in British Industry. A Report of an Inquiry undertaken by the National Institute of Industrial Psychology sponsored by the Human Factors Panel of the Committee on Industrial Productivity. Pp. 276. (London: Staples Press, Ltd., 1952.) 21s. net.

† The Framework of Joint Consultation. By J. H. Smith and Miss R. J. Carey. (Nationalized Industry Series, 10.) Pp. iii+35. (Claygate: Acton Society Trust, 1952.) 2s.

scarcely to have been attempted and is perhaps the more important because the conclusions drawn from this study are so slender. There can, in fact, be no one best form of structure and procedure for joint consultation. An appropriate system for a particular company must take into account the circumstances of that company—the material conditions, its organization, and the relationships and prevailing attitudes of the people at all levels within it. Those concerned with setting up a new organization or system will undoubtedly find that this report will amply repay a careful study.

"Any system of joint consultation, however, cannot long remain static and effective: it must develop to meet the changing needs of the organization or its usefulness will decline and it will gradually decay." To preserve vitality involves a task of mutual understanding and of education on both sides, and it is here that something more is required in the way of exposition or interpretation than we are given here. As a technique of management the scope of joint consultation is limited, and unless those limitations are clearly and generally understood there is the danger that unfounded expectations may lead to disappointment and further distrust instead of to confidence and harmony.

As a philosophy of management, joint consultation has wider possibilities; but here again there is much educational work to be done before it is fully understood and accepted with all its implications as the development of a democratic principle. Adoption of the consultative relationship as the basis for day-to-day conduct of the affairs of an organization is likely to foster the growth of understanding and realization of a common purpose between people whose interests may appear to them to be opposed; but there are examples enough given in this book to show how much has yet to be done to remove misconceptions and misunderstandings. Sir George Schuster, in his foreword, indeed suggests that while some important firms are making great advances, British industry as a whole is still only tinkering with the subject. Joint consultative methods, he urges, are a means to an end—the making of each industrial unit a harmonious, live, co-operating community, working together with a sense of common purpose which is understood and accepted by all its members. That ultimate aim is kept in view in this book, and if it does not go quite so far as is desirable in the task of exposition and interpretation, at least it provides a large amount of material from actual experience on such matters as the form of committees, the methods of selecting representatives, the difficulties of 'reporting back' the problems of relations with the trade unions and the like with which others could complete that task.

The Acton Society Trust paper brings out quite as well the need for a clear understanding of what is meant by joint consultation and advisory functions; but the position in the nationalized industries as given in this pamphlet differs considerably from that given by the study initiated by Sir George Schuster's Panel. All the industries nationalized since the War have been placed under a statutory obligation to set up machinery for joint consultation as well as for the negotiation of wages and conditions for employees. Primarily the Acton Society Trust sought to compare the varying organization established in the different industries, to inquire as to its effectiveness in practice and to consider the extent to which the size of the industries had created special problems for the working of consultation. In practice, the inquiry could not be limited to structure because defects in working arose from many varied causes.

In spite, however, of the differences, this study of nationalized industry corroborates much of the evidence given in the fuller inquiry of the Panel on Human Factors affecting Industrial Productivity. Indeed, the very factors which, in the nationalized industries, have been responsible for the difficulties in the way of joint consultation that have hindered its development on the lines expected and have even led to its impairing instead of improving relations, arise out of neglect of the conditions for successful joint consultation stressed by the inquiry into industry in general. The unions' insistence on uniformity of treatment in the nationalized industries and their desire to apply decisions over the largest possible area, the apprehensions of management, and the over-riding tendency of management and the trade unions to treat consultation as a method of exerting power, rather than as a method of exchanging views (with all the complications and untoward consequences of these attitudes and tendencies), are at bottom due to a complete misconception of the nature of joint consultation which the contrast drawn in these industries between joint consultation and negotiation tends to accentuate.

Until that misconception is removed, the realities of the situation will not be faced and there is little hope of real progress. The report prepared by the Panel on Human Factors is a real contribution to the task of education required, and, although the data it presents are drawn from outside the nationalized industries, they are as relevant to the problems of those industries as to the problems of industry elsewhere. It is to be hoped that the report will be carefully studied by all sections of nationalized industry, and that its findings and evidence will be further interpreted and expounded in a form likely to reach those who may never read the present report.

The Acton Society Trust does not present its study of the existing structure in the nationalized industries without some positive suggestions. Five general conditions are postulated for the organization of successful joint consultation: the structure must be comprehensible to those who use it; it must be laid down in an agreement between management and the unions; it should be subject to review and amendment; it should be developed in response to local demand; and it should include adequate arrangements for reporting back the proceedings of committees to those represented. Beyond this it suggests that the structure should also be related in some way to the manner in which employees are organized into working groups. The fourth and fifth conditions are those where the position is least satisfactory, and like the

tentative sixth condition they demand much more attention and examination in the light of a conception of consultation as a continuous relationship between groups of people which requires expression in appropriate forms.

In this study, however, the main emphasis is on the task of education. The most serious omission in the present arrangements in the nationalized industries, it is urged, is the general failure to provide any machinery for passing information about the work of the committees to the men they represent. As in the study initiated for the Committee on Industrial Productivity, emphasis is laid on the need for skilled leadership in the development of harmoniously working group or committee; but the main challenge of both these inquiries is to the task of education. Fresh constructive thinking about joint consultation both as a technique and as a philosophy of management is needed; but the most urgent need is to secure a widespread and clear understanding of what joint consultation really is, its limitations and its possibilities. For that task the report in particular supplies much useful material, but the Acton Society Trust paper is equally designed to stimulate the interpretation and exposition on which must be based an educational campaign as it desiderates.

BOTANY FOR THE DEGREE STUDENT

Textbook of Theoretical Botany

By Dr. R. C. McLean and Dr. W. R. Ivimey-Cook. Vol. 1. Pp. xv+1069. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 70*s*. net.

"THE attempt to write a textbook of Botany is an audacity which admits of no excuse but success." Few would disagree with this prefatory remark in the first volume of the new text-book of theoretical botany; all will admire the audacity, even if excuses are not sought, and may, indeed, ask if it is not audacity for a reviewer to attempt to criticize over so wide a field.

The authors have made no attempt at specialist treatment, but have tried to bridge the gap between the specialist books and those designed for first-year study. Realizing that the complete work will be both costly and bulky, they have sought to arrange their text so that it will serve for a beginner as well as for a more mature general botanical student. The aim, moreover, is to place factual material in the hands of the student and thus to free his teachers from the need to use their precious lecture time for presenting material of this sort.

It is on this basis, therefore, that the first volume of the new text-book must be judged, and the first essentials are that it shall be accurate, and lucid enough not to mislead. Mistakes could scarcely be avoided in a work of this magnitude; but fundamental errors, or vague and misleading statements, are not to be expected. It is on this count that the work falls short of perfection. A few examples may be given, though others might have been selected: p. 30, in the metaphase of meiosis, "the homologous pairs of chromosomes finite, then come on to the equatorial plane and separate, so that one whole chromosome of each pair goes to one pole and one to the other"; p. 31, reference is made to the heterotypic and homotypic divisions; and p. 32, Fig. 16 illustrates "formation of chiasmata in unsplit homologous chromosomes".

In an account of the algæ, which, the algologist might perhaps complain, have been afforded less generous treatment than the fungi, matters are little better: the definition of heterogamy on p. 51 is difficult to harmonize with that on p. 59; and on p. 104 the life-cycle diagram of *Cladophora* includes reference to an antheridium and an oogonium and to an antherozoid and an oosphere, while in that of *Dictyota* (p. 127) the implication that oogonia and antheridia occur on the same plant is, at best, misleading.

Equally unhappy are statements in other sections of the book: Fig. 697 is not likely to convince even the less sceptical students that there is much difference in the pitting of the araucarian tracheid and that of other conifers; the terms alburnum and duramen (p. 897) and autumn wood (p. 903) are surely a little out of date; does hæmatoxylin oxidize to logwood (p. 898)?; the account of tension and compression wood (pp. 904–7), if correct, is not remarkable for its lucidity, while the statement that, in trees grown in an equatorial climate, growth (of the wood) is continuous, is not as cautious as one might wish.

The book contains more than a thousand illustrations, and the authors are to be congratulated on the large number which are new. Many are from original photographs; but with some, and not a few, the reader may well not feel inclined to agree that the "naturalistic quality of photographs needs no emphasis": if examples are desired, reference may be made to Fig. 30, of *Chlamydomonas*, Fig. 88 of a *Gunnera* rhizome with *Nostoc* colonies, Fig. 269 of yeast, while it is doubtful if Fig. 857 would be recognized as collenchyma. The plain fact would seem to be that a good drawing is often greatly to be preferred to a photograph, and some of these illustrations appear to furnish ample confirmation of this contention.

FRANK W. JANE

ENZYMES

The Enzymes

Chemistry and Mechanism of Action. Edited by James B. Sumner and Karl Myrbäck. Vol. 1, Part 1; pp. xvii+724; 13.50 dollars. Vol. 1, Part 2; pp. x+725–1361; 12.80 dollars. Vol. 2, Part 1; pp. xi+790; 14.80 dollars. Vol. 2, Part 2; pp. xi+791–1440; 14 dollars. (New York: Academic Press, Inc., 1950–52.)

THE publishers of these four books, two parts to each of two volumes, have printed at the front and top of the jacket the words "A new encyclopædic work". The stunned reviewer might be forgiven for doing no more than feebly murmur "Agreed, agreed"; but to do so might suggest discourtesy to editors, authors, publishers and potential readers. Despite the obvious fact, therefore, that such a treatise can scarcely more easily be reviewed than it could have been written by one person, an attempt should at least be made to indicate the scope of the work, of which the first part was published no less recently than December 1950. During the subsequent eighteen

months the three remaining parts have brought the total number of pages to 2801. The two parts of each volume have been paginated continuously but separately: at the end of Vol. 1 (1362 pp.) are an author index (49 pp.) and subject index (46 pp.); the corresponding figures for Vol. 2 (1440 pp.) are 53 and 49 pp. At the foot of each page of index to Vol. 2 is repeated a statement to show on which pages Part 1 of the volume ends and Part 2 begins; unfortunately, no such convenient reminders appear in the index to Vol. 1.

In Great Britain, where divers systems of giving references pertain, scientific readers are developing an almost pathological interest in the method adopted by particular authors or editors. For their information it should be stated that in these four volumes references are indicated by serial superscript numbers, the full bibliographical details appearing at the bottom of the page of first mention. This has made necessary a procedure that is a little puzzling at first, for we find as a note to the author index of Vol. 1 the words "The numbers in parentheses are footnotes". This is explained by clearer and more extensive phraseology in a footnote to the corresponding index of Vol. 2, where it is made apparent to the probably baffled users of Vol. 1 that the bracketed numbers are, in fact, the serial reference numbers to papers mentioned on a particular page but given full descriptions on an earlier page. In this matter also, therefore, the editors have in Vol. 2 made good a defect of Vol. 1. With the textual superscripts, the description at the bottom of the individual pages and the two complete author indexes, details of a paper by a particular author can be found at a reasonable speed and one that on the average varies inversely as the author's fecundity. The same paper may, naturally, appear under two separate reference numbers in two chapters, but not in the same one.

There are altogether seventy-eight different names given in the lists of authors at the beginning of the four parts. Their national distribution is, in itself, of some interest: United States, 48; Great Britain, 9; Sweden, 8; Finland, 3; Germany, France and Denmark, 2 each; Turkey, Australia, Switzerland and Belgium, 1 each. There happen also to be just seventy-eight chapters to the combined two volumes; but this is pure coincidence, for sixty-three chapters have single names at their heads (in several instances the same names appear over at least two chapters), eleven are the result of dual authorship, and four come from a treble collaboration.

At the risk of appearing invidious by selecting particular authors for individual mention, it seems nevertheless legitimate to record those of the British contributors, Dr. E. P. Abraham (penicillinase), Dr. N. J. Berridge (milk coagulation), Prof. F. J. W. Roughton and Dr. A. M. Clark (carbonic anhydrase), Prof. Frank Dickens (anaerobic glycolysis, respiration, and the Pasteur effect), Dr. S. R. Elsden (bacterial fermentation), Prof. H. A. Krebs (oxidation of amino-acids; urea synthesis), Prof. J. R. Marrack (enzymes and immunology), Dr. E. A. Moelwyn-Hughes (physical chemistry and chemical kinetics of enzymes). These authors and their subjects are, incidentally, random samples of both, for the net of the editors has been cast so wide as to make nationality a variable independent of subject—in both senses of the word. They therefore convey a fair notion of the breadth and depth of the editors' plans and achievements; this is substantiated when we find such further names as those of Holman and Bergström (lipoxidase or unsaturated-fat oxidase), Bernheim (enzymes in detoxication), Philip Cohen (transaminases; enzymatic synthesis of glutamine; peptide bond synthesis), Fromageot (sulphatases; desulphinase; desulphhydrases; oxidation of organic sulphur), Greenberg (arginase), R. S. Harris (thiaminase), Kalckar (dephosphorylation of adenosine polyphosphates), Massart (enzyme inhibition), the late Otto Meyerhof (enolase; aldolase and isomerase), Michaelis (theory of oxidation-reduction), Ochoa (fumarase and aconitase; enzymatic mechanisms of carbon dioxide fixation), Seegers (blood coagulation), Theorell (flavin-containing enzymes; the iron-containing enzymes, catalases and peroxidases, "hydroperoxidases"), Umbreit (hydrogenase and hydrogenylase), Virtanen with J. Erkama (aspartase) and N. Rantanen (nitrogen assimilation).

This additional, almost random, selection of chapters, written by authors whose original contributions to the subject are known all over the world, gives a further idea of the ground the editors set out to cover. They themselves contribute a foreword and the opening chapter, simply entitled "Introduction"; in it they cover such various topics as definitions, terminology, classification, history, the chemical and general properties of enzymes and the determination of their activity. The anatomy of this chapter naturally differs from that of the others; but these also show no common pattern, each author or group of authors having—wisely, I think—been left to devise the most appropriate subdivision of subject-matter.

To the topics already enumerated above, others of particular interest may be mentioned, namely, enzyme specificity (Helferich), acetylcholine hydrolysis and synthesis and choline esterases and acetylase (Augustinsson), the α-D- and the β-glucosidases (Gottschalk and Veibel, respectively), pectic enzymes (Kertesz), proteolytic enzymes (E. L. Smith), phosphorylases (Hassid, Dondoroff and Barker), the fundamental physical chemistry of phosphate bonds (Kaplan), the cytochromes (K.-G. Paul), luminescence phenomena (Harvey), photosynthesis (Loomis), tumor enzymology (Greenstein and Meister) and—the last chapter of Vol. 2, Part 2—enzyme technology (Langlykke, Smythe and Perlman). Here also we find evidence of wide scope and authoritative treatment.

The most casual dipping into these pages, edited by Dr. J. B. Sumner (of Cornell University) and Dr. Karl Myrbäck (of the University of Stockholm), indicates what more intensive reading confirms—the extraordinary thoroughness with which the field named in the book's sub-title has been surveyed. Despite the intensity of investigation still maintained in that field, showing no signs of abatement and involving the publication of much new knowledge since even the latest in date of the book's content went to press, this work must remain for many years what it certainly is to-day—a cornucopia of information about every aspect of enzyme chemistry and action, an invaluable saver of time and energy in searches through the literature, a potent stimulus to the research worker himself and an immense credit to all concerned in its inception, production and publication. The total cost of the two volumes in four parts is of the order of £20, and this might seem formidable even to the wealthier specialists. In fact, it works out at rather less than 2*d*. a page, which perhaps puts a different complexion on the matter.

A. L. Bacharach

LUMINESCENCE OF SOLIDS

An Introduction to Luminescence of Solids

By Humboldt W. Leverenz. Pp. xv+569. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 96*s*. net.

PHOSPHORS are now manufactured by hundreds of tons a year, the amount having increased ten-fold with the development of fluorescent lighting. Television and radar use quantities of the order of twenty tons a year of more exacting phosphors, and there are other uses for X-ray screens, self-luminous radioactive paints, and luminous plastics and tapes for a variety of purposes. With the increasing availability in reproducible forms, since they are difficult to make on the small scale, ingenious devices employing them are likely to increase in the future.

There are two ways of developing a theory of phosphors. One that has been very popular is to begin from the ideas used for explaining the properties of semi-conductors, which lead to generalized concepts such as 'activator centres', 'electron traps', 'excitons', 'phonons', etc. This method treats the crystal as a whole and is helpful in attempts to understand how energy can pass from the non-luminescent bulk to particular centres from which emission occurs. The other method is to emphasize the essentially atomic or molecular nature of the luminescence as shown by uranyl salts or aromatic hydrocarbons, for example, the fluorescence of which scarcely changes from solid to solution, and to focus attention more on the nature of the emitter as a chemical particle than as something irregular in the ideal lattice of an 'impurity-activated' phosphor.

In early work the identification of the emitters was obscured by the fact that incredibly small amounts of impurities sometimes exerted a dominating effect; in this book Dr. H. W. Leverenz here defines ideal 'luminescence purity' as 99·9999 per cent and 'spectroscopic purity' as 99·999 per cent. There are now signs, however, that the fashion is changing, as in other fields, with a swing away from communal electronic physical theories to individualistic chemical interpretations, where considerations of atomic volume and variable valency are significant.

The book is the fruit of twenty years of experience on the preparation of phosphors of all types. The author is an outstanding authority, well conversant with every side of physics and chemistry related to the subject, cautious, accurate and systematic. He states, "During the alchemical infancy and haphazard growth of the phosphor art, the resultant desultory and greatly dispersed literature on luminescence of solids has become cluttered with confused terminologies, incorrect data, and baneful misconceptions. As an antidote this book seeks to be objective, to provide a rational terminology, and to furnish a critical guide to the literature". In seeking for accuracy of definitions and statement, the author has allowed his style to become somewhat ponderous. He first builds up a massive apparatus of physical theory, only to show in the end to what little quantitative purpose it can be put. After advanced considerations of energy-levels in imperfect crystals, he dismisses the simpler concept of potential energy curves as "artistically stimulating; some may incorporate verity, but they have yet to achieve practical significance". Finally, after all the elaborations of physical theory, he states: "At present, in the absence of a satisfactory compilation of phosphors and phosphor properties, it is usually necessary to enlist the aid of a phosphor expert *with broad experience* in order to assure obtention of the best available phosphor for a particular purpose".

This is an extremely valuable book for all workers on luminescence, containing matter, not obtainable elsewhere, on every aspect of theory, methods of phosphor manufacture, different types of phosphor and their detailed uses, modes of excitation, decay characteristics, etc., with a multitude of precise definitions and physical data. Although entitled an "Introduction" and therefore expressing only a fraction of the author's own knowledge and experience, it is, in fact, a very extensive and detailed account which will absorb the full attention of one coming newly to the subject. E. J. BOWEN

WORLD POPULATION AND FOOD

Geography of Hunger

By Josué de Castro. Pp. 288. (London: Victor Gollancz, Ltd., 1952.) 18*s*. net.

OF the three historic checks on population growth—war, famine and pestilence—the last-named is being dramatically curtailed by modern techniques. The ensuing population increase is both sudden and immense, and it is presenting the world with one of the biggest problems it has ever had to face, that of providing food (and other necessities) for this rapidly increasing multitude.

The author of this book believes firmly that enough food could be produced and that only the will is lacking. He cites examples from all parts of the world to show that malnutrition and frank hunger are widespread even now; but he lays the blame for this squarely at the door of Western European civilization with its domination over the 'backward areas'. Much of his criticism is valid; but the exploitation of man by man is by no means the only factor which limits the world's food supply, and no one should read this book without also reading Vogt's "Road to Survival" and Cook's "Human Fertility".

The author dismisses as "alarmist" those who press the need for a voluntary control of population increase to replace the harsh, natural checks; but he has the grace to remind his readers that "the United States of America, using fertilizers on a scale without precedent in the history of agriculture, has already exhausted 100 million acres of land in less than two centuries of cultivation".

There can be little doubt but that many apparently successful measures merely postpone the day of reckoning while adding to the bill to be paid, and it is unfortunate that this book has been published at a time when its author is chairman of the executive of the Food and Agriculture Organization, as this gives it an air of quite unwarranted authority. (It is not, of course, in any way an official publication.) The evidence presented has been collected by means of "a widespread correspondence" and "talks with strategically placed personalities" and, inevitably, not all of it rings true. Few countries are fully documented with regard to their vital statistics, food production, economic resources, etc., and many of the figures which the author uses are, at best, no more than informed guesses; they provide a very insecure base for the rather fantastic edifice he builds upon them; but the general reader may not realize this, and false beliefs and false hopes will be engendered.

The early chapters are spoilt by a florid style of writing, of which two examples will suffice. About vitamin D, it is said that, "the sun . . . pours forth this vitamin like a divine manna from the cornucopia of the heavens", and scurvy is described as "one of the more vivid of human miseries, gaudy with blood from the hæmorrhages of its victims, the strange bruised appearance of their purple skins and the ghastly stench of their rotting gums".

The issues dealt with in this book are, as Lord Boyd-Orr says, "of the first magnitude". They are urgent and immense, and they call for care and wisdom from both men of science and politicians, if they are to be solved. The emotional approach of this book does little to help. M. W. Grant

ON GROWING OLD

Commentary on Age

By Kenneth Walker. Pp. 192. (London : Jonathan Cape, Ltd., 1952.) 12*s*. 6*d*. net.

DR. KENNETH WALKER is a distinguished surgeon ; his book is part philosophy, part science and part common sense. The philosophy is philosophical in the good old-fashioned sense : it is a reflexion on the conduct of life, in one of its epochs, and the dispositions that must be made to meet its enemies, with special reference to the last enemy of all. Dr. Walker writes simply, and sometimes movingly, of the rewards and sadnesses of growing old, and skilfully dissects the inevitable disabilities of ageing from those which, arising from unpreparedness, are the punishment for an earlier spiritual improvidence. He has not much new to say, it is true, and the title of his book makes no such claim for it ; but wide reading and a genial eclecticism make what is true seem manifestly true, and to do that is the chief business of the commentator. What Dr. Walker says of our ageing population and the provision that must be made for the elderly is all good sense, and with such reasonable and even-tempered advocacy it may not be too long before opinion becomes policy, and policy becomes practice.

The reader must be warned, however, that the part of the book that purports to be scientific scarcely deserves to be so described. Ominous minor errors such as the mis-spellings of the names of Ebeling, McCay and Korenchevsky, the confusion of Bogomolets *père* with *fils* and of Jacques with Leo Loeb make it all too clear that Dr. Walker is not too familiar with his original sources. It is not simply a matter of minor misconceptions, such as the suggestion that elephants may live for two hundred years, or the mayfly for but a few hours, or of the uncritical acceptance of the importance of senile dehydration, the sexual rejuvenation of *Paramecium*, or the beguiling metaphor of 'physiological time'. It is mainly that the entire treatment is in a multitude of ways inexpert and unanalytic ; there is no real grasp of the problem of measuring senescence, of the importance of studying the expectation of life of wild animals in the wild, or of the degree to which the senile state is one which only domesticated animals are spared to display. More serious still, one gets the feeling that Dr. Walker is inclined to equate the analysis of the scientific problem of ageing with *ad hoc* researches into the prolongation of life.

This is harsh criticism, which may be more than half countered by the retort that the book is not addressed to a professional audience and that, except in one respect, the man of science is not likely to use it as a work of reference. The exception is Dr. Walker's appraisal of the clinical value of testicular grafting, as it had been practised by Voronoff to revive the flagging energies of the elderly. He finds that even homoio-transplants of human testes are rapidly absorbed, and is highly sceptical of Voronoff's claim to have succeeded with heterografts of testes from chimpanzees. This is useful evidence on a subject on which Dr. Walker writes with personal authority. P. B. Medawar

A FAUNA OF FARM ANIMALS

A World Dictionary of Breeds, Types and Varieties of Livestock

By I. L. Mason. (Commonwealth Bureau of Animal Breeding and Genetics, Technical Communication No. 8.) Pp. 272. (Farnham Royal : Commonwealth Agricultural Bureaux, 1951.) 30*s*.

ALTHOUGH complete lists and descriptions of wild animals, birds and even insects exist, no world list of the different breeds, types and varieties of farm animals has been available. The first part of this book attempts to supply this.

As mentioned in the introduction, this list requires supplementing with maps and illustrations of the breeds, and it is hoped that these may be forthcoming at a later date. It is comparatively easy to find details for improved breeds which have a herdbook ; but there are a large number of native breeds in Asia and Africa about which knowledge is sadly lacking. This is required if production in the backward areas of the world is to be improved. As the title indicates, the book is a dictionary to be consulted and not one to be read ; references are given, however, to papers which contain descriptions of the breed in question. The second part of the book, which gives livestock numbers and breeds by countries, together with references to publications concerning the breeds of these countries, should prove most useful to those who require a bird's-eye view of the livestock production of any area. For the temperate zones and the more highly developed areas of the world, a very good picture is presented ; but, through no fault of the author, the information given for the tropical zones of the world is lamentably small, consisting of, in many cases, a catalogue of breeds only. Possibly steps already taken by the United Nations Food and Agriculture Organization to collect information for those areas may soon bring our knowledge of domestic animals on a par with our knowledge about wild species. New breeds with improved production qualities suitable for tropical areas, such as the Santa Gertrudis cattle (3/8 zebu, 5/8 shorthorn), are now being formed, and may before long drive many of the primitive breeds to extinction, as has occurred with improved breeds in Great Britain. Before this is done, these primitive breeds require study for qualities suiting them to their habitat, so that some of them at any rate may be preserved and the valuable genes they contain retained for use in the future.

The species dealt with are the horse, ass, cattle, buffalo, sheep, goat and pig. The first part gives some four thousand entries, listing the various names which have been used, and for each breed mentioned it recommends an English name. Some information about breed characters, origin and relationship to other breeds is given. John Hammond

ENGINEERING, BIOPHYSICS AND PHYSICS AT KING'S COLLEGE, LONDON

NEW BUILDING

THE new physics and engineering laboratories at King's College, University of London, were opened formally by Lord Cherwell on June 27. These laboratories have been built in the only place available, below ground, in the space previously occupied by vaults which had been broken open by bombs during the Second World War. The proximity of Somerset House prevents any part of the building from projecting above ground-level, and the height of the water-table determined by the neighbouring Thames limits extension downwards. Between these levels a two-story building has been constructed, the presence of which would scarcely be suspected by anyone who, entering King's College from the Strand, drives or walks over the asphalt surface of the quadrangle which forms the roof of the building. However, the laboratories are extensive and, being decorated inside in bright colours and lit by fluorescent lighting and by a surprisingly large amount of daylight entering from large windows on one side, suffer relatively little from their subterranean condition.

Both physics and engineering at King's College are distinguished by the antiquity of their foundation. The first professor of natural and experimental philosophy was appointed in 1831. Charles Wheatstone was made professor of experimental philosophy in 1834 and developed the celebrated Wheatstone bridge. The College can claim to be the oldest academic institution in England to teach experimental physics, as the Clarendon Laboratory at Oxford and the Cavendish at Cambridge were founded respectively in 1868 and 1871. Later, Clerk Maxwell was a professor, and the high traditions of the department were maintained by H. A. Wilson, C. G. Barkla, Sir Owen Richardson, Sir Edward Appleton and Sir Charles Ellis, three of whom became Nobel laureates.

The Faculty of Engineering, which dates from 1838, is the oldest university engineering school in Great Britain and Ireland, the first professor (William Hosking) having been appointed in 1840, three weeks before Lewis Gordon became professor in Glasgow.

Department of Engineering

In its beginning, the Department of Engineering at King's College included in its teaching architecture and metallurgy. To-day, undergraduate study covers civil, mechanical and electrical engineering, which are continued in postgraduate work together with chemical engineering. The heads of these departments are, respectively, Prof. A. D. Ross, Prof. S. J. Davies, Prof. J. Greig and Mr. S. B. Watkins. It is of interest that King's College Engineering Society, an undergraduate body, is the oldest engineering society of any kind in Britain and was founded in 1847, six days before the Institution of Mechanical Engineers.

Most of the space for engineering in the new building is devoted to teaching, and comprises a new drawing office, a library, laboratories for soil mechanics and for the study of structures and mechanical vibrations, and for certain branches of electrical engineering. The space in the old building made available through the provision of the new drawing office is now reconstructed as a laboratory for concrete technology.

On the electrical engineering side there are two new teaching laboratories, one for machines and one for light-current work. A new research laboratory is being equipped mainly for work on automatic control systems, and a new workshop and additional photographic facilities have been provided. The research interests of the department lie mainly in the field of electrical measurements, in particular in relation to non-linear phenomena of magnetic origin. The new laboratories include a standards room in which much of the equipment will be associated with this work.

In the Engineering Faculty the research activities are distributed throughout the individual specialist laboratories and will not be concentrated in the new building.

Physics Department : Wheatstone Laboratory

Biophysics Research. The department, under Prof. J. T. Randall, is, of course, responsible for the teaching and research in physics ; but a large part of the research is biophysical, and is concerned essentially with the solution of biological problems. To understand the nature of such biophysical research, which is somewhat unusual in a physics department, it is useful to consider its character and origin. Organization of science (for example, in university departments) naturally requires much modification in order to meet the needs of these new trends.

The increasing size of the body of scientific knowledge and lack of linkage by common theory between its parts has naturally resulted in the separation of science into various subjects, each studied in the universities by specialists in independent departments. Biology, in particular, has developed independently of physics. However, the process of the sciences separating is reversed, and re-integration becomes possible, when an all-embracing fundamental theory is developed. Such theoretical development has enabled chemistry and physics to fuse with parts of biology, thus producing the new subjects of biochemistry and biophysics, which have the complementary aspects of being both new specializations and syntheses of science. Biochemistry is a coherent subject ; but biophysics is heterogeneous and exists in many aspects and more as a trend in certain aspects of biology than as a subject in itself.

The theory behind this biophysical trend is mainly the electron theory of molecular structure, which, having already reduced much of chemistry to physical terms, now, by way of biochemistry, begins to describe and explain in terms of electrons and molecules the properties of living matter and the nature of biological processes. Application of such fundamental theory makes possible the explanation and linkage of phenomena in many fields, and, as a result, it should become easier for a scientific worker to have a measure of real understanding of several branches of science. The effect on the research worker, therefore, is to enable him to return in some ways to the comprehensive view of the natural or experimental

philosopher. In fact, progress in biophysics depends largely on the development of such research workers who will have a broad approach resulting from synthesis of the traditions of physics and biology.

Physics finds application in biology, not only in the theoretical approach but also in the use of many new physical techniques. Perfected physical tools (for example, the ordinary compound microscope) may be operated by biologists, but collaboration with physicists is desirable when the information obtained by the method is essentially physical in nature as well as biological; or when the development and operation of the technique requires much physical insight. The aid that physicists can give biologists by providing new techniques is an important aspect of biophysics; but elucidation of biological phenomena in terms of molecular theory has ultimately greater significance.

These trends in certain aspects of biology have developed during the past thirty years—in most cases not under the name of biophysics—in university departments of chemistry, biochemistry, physiology, etc. It has also often been necessary to create new departments of biophysics, research units and research institutes.

Owing to the complicated nature of biophysical problems, it is generally desirable to approach the same subject from many different angles and by use of a wide range of techniques. This is best achieved by mutually sympathetic and understanding specialist biologists, biochemists, physicists and hybrid scientists working in one laboratory and allowing their efforts to unite. A biophysics laboratory will tend to be large because it must contain both a large personnel and an exceptionally wide range of facilities.

To expand a physics department in a biological direction it is necessary to go outside the normal university departmental framework. Biology graduates can scarcely hold posts as teachers of physics, or *vice versa*. At King's College this difficulty is overcome by the inclusion in the Physics Department of a Medical Research Council Biophysics Research Unit, which contains scientists and technicians other than physicists. Apparatus has been provided by King's College, the Medical Research Council, the University Grants Committee and the Rockefeller Foundation. Further staff and apparatus have been provided for by research fellowships and grants from the Nuffield Foundation, the British Empire Cancer Campaign, the Rockefeller Foundation, and Imperial Chemical Industries, Ltd. Research students are physics graduates and biologists, and biophysics is a recognized subject in the University of London for postgraduate study. When physics graduates become research students in biophysics, they are required to attend courses in biology. In order that biophysicists should preserve a rigorous approach to the main branch of science in which they have graduated, the research workers who are not on the physics teaching staff of King's College usually contribute to the teaching in other appropriate departments of the College.

The biophysics research at present involves about twenty-four graduates, including four biologists and two chemists, and there are twenty-seven technicians, both biological and physical. Dr. Honor B. Fell, director of the Strangeways Laboratory, Cambridge, acts as senior biological adviser to the Medical Research Council Unit.

One aspect of the biophysical research of the Department is concerned with the structure and function of various biological fibrous molecular systems. Collagen provides a favourable opportunity of studying the structure of protein in relation to its function and mode of formation. Connective tissue composed of collagen grows with a quasi-crystalline structure from smaller protein units in solution, and the resulting fibres have a very great tensile strength correlated with a highly oriented system of chemical bonds.

The fibrous molecule of deoxyribonucleic acid is often supposed to have a special function in relation to protein synthesis. It has been found possible to crystallize the pure substance in the form of fibres and then to determine, by X-ray diffraction, many of its structural characteristics, which can also be shown to exist in living sperm cells and in the nuclei of growing cells. The structural relation of protein to nucleic acid is also being elucidated, and this may cast light on the mutual role of nucleic acid and protein in growth, and the relation of these molecular patterns to specific chemical differences associated with gene action.

The other main aspect of the biophysical research is the development and application of physical methods to determine the distribution of chemical substances in growing cells. Ultra-violet, infra-red and interference microscopes are used to measure the concentrations of nucleic acid, protein and other substances. Thus, from the cytochemical side, the functional relationship of nucleic acid and protein is studied, and this connects with the molecular structure approach to the same question. The development (by use of a microscope interferometer) of successful reflecting microscopes for this work has involved much physical study.

On the biological side, the department has all usual facilities, including an animal room and tissue-culture laboratories. There are two time-lapse phase cinémicroscopes in 'hot-boxes'; a 35-mm. camera on each biologist's microscope; cytological freeze-drying equipment; several ultra-violet microscopes; a high-power ultrasonic generator; and a flying-spot microscope.

On the more physical side, there are two electron-microscopes and a 400-kV. instrument nearing completion. Three ultra-violet and two infra-red microspectrometers together with five reflecting microscopes are at present in use. A semi-fine-focus X-ray tube and two fine-focus tubes are used in conjunction with several microcameras and a long-spacing diffraction camera.

Biochemical facilities include cold rooms at 0° C. and −20° C.; an ultracentrifuge; electrophoresis apparatus; and a 12-litre centrifuge, ultra-violet spectrophotometers, etc.

Theoretical Physics. A strong theoretical group of about twelve workers has been engaged under the direction of Prof. C. A. Coulson on applications of wave mechanics and statistical mechanics. The theory of the chemical bond has been developed and applied to questions of the chemical reactivity of molecules, the stability of crystal structures, biological properties of molecules such as cancer-producing chemical compounds, electrical and magnetic properties of metals, etc. A second aspect of the work concerns properties of electrolytes and colloidal solutions, including the theory of electrophoresis. The activity of the theoretical physics group at King's College may be judged from the fact that more than one hundred papers have been published during the past five years.

Experimental Physics. Apart from biophysics, there are several distinct physics research groups in the Wheatstone Laboratory.

One group is studying effects produced by nuclear radiations and light on various crystalline insulators such as diamond. Variations in the texture of diamonds have been shown to cause wide changes in some of their physical properties. This work has the dual purpose of developing radiation detectors which utilize such effects, and of increasing knowledge of how energy is transported and converted in insulators and semi-conductors.

Another group is concerned with the temporary distortions produced in the earth's electric field due to thundercloud disturbances. The relation of the propagation of this field distortion, the wave-form, and its frequency analysis are studied by means of multi-tube cathode-ray wave-form recorders and radio spectrometers installed on the roof of the College.

An electronics group is concerned with the development of high-speed electronic-analogue computing techniques and their applications to a variety of physical and biophysical problems. Two high-speed computing instruments have been built. Techniques are also being developed for the study of the central nervous system from the point of view of information theory.

In connexion with biophysical applications of spectroscopy, investigations of the fundamental relation of optical properties to molecular structure are being made by a spectroscopic group. The ultra-violet and infra-red absorption of small molecules and crystals of known structure is being measured by means of high-dispersion equipment using polarizers, reflecting microscopes and automatic recorders. Fundamental studies in the vacuum ultra-violet are also in progress. M. H. F. WILKINS

LONG ASHTON RESEARCH STATION

OPEN DAY

AT the University of Bristol Agricultural and Horticultural Research Station's Open Day on July 15, several items of particular scientific interest were demonstrated. In the Pomology Section, Dr. L. C. Luckwill dealt with fruit-thinning sprays containing α-naphthalene acetic acid. These, applied to apples within three or four weeks of petal-fall, induce seed abortion, and consequently an increased drop of young fruits. The concentration required to give satisfactory thinning is affected by the variety, the initial set of fruitlets and the stage of development at the time of spraying. The method, therefore, cannot yet be safely recommended in commercial apple growing.

Paper chromatography is being employed at Long Ashton in the study of the natural auxins controlling fruit development. An exhibit showed some of the biological tests employed for locating the position of the auxins on the chromatograms. These include a modification of the coleoptile cylinder test and the *Coleus* petiole abscission test.

In the plant nutrient investigations under the direction of Dr. E. J. Hewitt, specific visual symptoms on the cauliflower plant were used to demonstrate its molybdenum requirements in the presence of nitrogen applied respectively as nitrate, nitrite, ammonium or urea. Nitrate consistently induced a characteristic mottling, absent from plants given the other treatments.

A survey of the copper, zinc and molybdenum requirements of large-seeded legumes demonstrated that the seed reserves in dwarf, runner and broad beans and in peas could provide sufficient molybdenum for one year's growth but rarely for two. Seed reserves of these crops also mitigated the effects of copper and zinc deficiencies. In comparative trials of water purification methods in the study of molybdenum, copper and zinc requirements, the behaviour of test crops showed that rainwater demineralized by a suitable ion-exchange resin was similar to glass-distilled water.

Iron deficiency was induced in sugar-beet by excess of copper, zinc or manganese. The degree of chlorosis produced was increased by extra molybdenum and, outstandingly, by copper.

The exhibits dealing with insecticides included a demonstration by Mr. S. H. Bennett (working in collaboration with Dr. W. D. E. Thomas) of biological methods using chrysanthemum plants infested with *Macrosiphoniella sanborni* for tracing the movement of octamethyl pyrophosphoramide (schradan) through the plant. This method used in conjunction with radioactive tracer techniques permitted accurate study of the translocation of the insecticide.

Dr. R. J. W. Byrde, of the Mycology Section, demonstrated the effect of winter spray treatments in inhibiting sporulation by *Nectria galligena* (causing apple canker) and *Sclerotinia fructigena*, the brown rot fungus. The effect on *Nectria galligena* was sufficient to reduce subsequent leaf scar infections; but in *S. fructigena* the supply of spore inoculum could be built up sufficiently quickly to outweigh the effect of the winter treatment.

In an exhibit illustrating improvements in spray nozzles, Mr. N. G. Morgan and Dr. H. G. H. Kearns showed two standardized designs. The first was a light-weight all-purpose ¼-in. B.S.P. nozzle, with interchangeable parts for high- or low-volume spraying at low pressures (30–75 lb./sq. in.), suitable for light lances, ground-crop booms or air-flow machines. The second was a ¾-in. B.S.P. nozzle intended mainly for high-pressure (200–400 lb./sq. in.) spraying of fruit trees by means of hand lances or spray masts.

The exhibits of the Cider and Fruit Juices Section (under the direction of Dr. A. Pollard) were concerned both with the practical aspects and with some of the more fundamental work at present being undertaken on cider and apple juice production. In an exhibit emphasizing the microbiology of cider making, photomicrographs illustrated the yeasts and bacteria capable of giving rise to disorders of cider. The latter included 'sickness' bacteria and lactic rods responsible for the condition known as 'ropiness'. The use of acetic bacteria in the production of cider vinegar was the subject of a practical demonstration.

An exhibit of unfermented apple juices illustrated oxidation phenomena during processing and storage. The addition of small amounts of sulphur dioxide at the time of milling the fruit was shown to inhibit the initial rapid oxidation of polyphenolic components which normally occur, the amount required exhibiting wide variation according to fruit variety. Adequate exclusion of oxygen from the bottled and pasteurized product was shown to inhibit the slower oxidative changes which occur on storage.

The result of field trials with selected varieties of cider apples grown as bush trees was illustrated by

Dr. Luckwill and Mr. R. R. Williams. Average annual yields over a period of three years have ranged from less than one to over thirteen tons per acre, depending chiefly on the variety. These intensive methods of cider fruit production have brought their problems of pollination, and work is in progress to determine the self- and cross-fertility of the recommended varieties. A provisional list of the triploid varieties of cider apples was displayed. R. W. Marsh

STRUCTURE OF ELASTIC TISSUE

By Dr. D. A. Hall, Dr. R. Reed* and Prof. R. E. Tunbridge, O.B.E.

Departments of Medicine and of Leather Industries, University of Leeds

Elastic fibres are described in standard histological texts as being yellow in colour, highly refractile and as exhibiting considerable elasticity[1]. The fibres run singly, branch freely and anastomose with one another and can be differentiated by selective stains such as acid orcein and resorcinol fuchsin. They form the major component of the elastic tissue of aortic media and ox ligamentum nuchæ. It has been shown[2] that the apparent increase in elastic staining in certain pathological conditions of the skin may not necessarily be associated with similar increases of elastic fibres, as identified under the electron microscope, but may be due to the presence of altered collagen. Such anomalies in the basic criteria for the identification of elastic fibres and elastin led us to study the morphological and chemical characterization of elastic fibres, and the present communication summarizes our observations of human aortæ and ox ligamentum nuchæ.

Histological examination has confirmed the findings of Benninghoff[3] that there are in the media of human aorta two components, fibrils and lamellæ, to which the name elastin could be given on the basis of their staining properties. By contrast ox ligamentum nuchæ consists solely of large fibrils running parallel to the long axis of the fibres. Morphological differences are also evident under the electron microscope. Disregarding the fibrils of collagen which are a characteristic and easily definable component of all elastic tissue, the aortic media contains ill-defined branching fibres, some of which are apparently made up of still smaller fibres embedded in an amorphous matrix. The large lamellæ observed under the light microscope contain similar elements. On the other hand, ox ligamentum nuchæ consists solely of dense broad fibres of circular cross-section arranged in parallel formation and exhibiting no branching.

Both tissues react similarly when treated with pancreatic elastase. Some of the cementing matrix is first digested, the fibres becoming less opaque and collapsing, revealing an array of fine fibrils, lying roughly parallel to the long axis. These fibrils are quickly broken down into small particulate material. Thus the action of elastase points to a morphological similarity between the two tissues, although under the light microscope considerable differences are apparent.

The chemical evidence is similarly confusing. The majority of data previously available had been obtained from studies on ox ligament and had shown that elastin differed from most albuminoids in that it was remarkably insoluble in the normal solvents for proteins, while those reagents capable of dissolving it apparently did so only with considerable degradation. Total analyses have been made by Richard and Gies[4], and amino-acid analyses of preparations believed to be pure elastin have also been made by Stein and Miller[5] and by Neuman[6]. Stein and Miller[5] used either boiling 40 per cent urea solution for protracted periods or short treatment with water to remove associated proteins, and reported that the analyses of the materials remaining were identical. Later workers have used the simpler method of preparation to minimize degradation of the protein, but it has recently been reported by one of us (Hall[7]) that treatment of human elastic tissue with hot water or acetic acid, although previously presumed adequate for the removal of collagen, does not free the preparation from all proteins other than the elastin of Stein and Miller. A fraction remains resembling collagen on analysis, having both basic amino-acids and hydroxyproline in excess of the accepted values for ox ligament elastin, but having neither the striated structure nor the solubility properties of collagen. Hence all analyses of tissue for elastin content based on the separation of elastin as a fraction insoluble in water or acetic acid[8,9] will give erroneously high values in tissues such as human aorta where the extra component appears to be present. The acetic-acid-resistant protein can be removed from elastin by prolonged treatment with dilute solutions of urea, hence the method of Neuman and Logan[10] should give more reliable results with human tissue. The material remaining after the removal of collagen and the extra component has an amino-acid analysis identical with elastin preparations obtained from ox ligament by the action of acetic acid alone. This is further evidence of the complexity of human elastic tissue as compared with that from ox ligamentum nuchæ and, at the same time, of the possible existence of a common component.

The insolubility of elastin in boiling 40 per cent urea solutions, as claimed by Stein and Miller[5], has been shown by Hall[7] to be relative and dependent only on the ratio of urea to elastin. The product of such a reaction with urea is a soluble protein which from preliminary ultracentrifuge and osmometry observations appears to be of low molecular weight and which from electrophoretic data migrates as a single peak over a *p*H range of 2–10. Further, no free amino-acids have been identified in the dialysate; but, most significantly, polysaccharide and acid are released during solution. This protein species is also reversibly denatured by heat, the temperature at which this is brought about varying with *p*H and ionic strength of the environment and being lowest (14° C.) at *p*H 2·8 and at an ionic strength of μ–0·2. This soluble protein, therefore, is similar in some respects to that reported by Adair, Davis and Partridge[11] as being produced from elastin by the action of 0·25 *M* oxalic acid. Their protein was a mixture of two fractions, one with a molecular weight of 84,000 showing thermal denaturation and the other of much lower molecular weight and not denatured by heat. A further significant difference is the short duration of the oxalic acid reaction and the reported presence of acidic amino-acids in the dialysate, phenomena which Adair *et al.* attribute to incipient hydrolysis of the elastin molecule. Recently, Wood[12] has demonstrated that other methods, such as prolonged boiling with 0·1 *N* sodium hydroxide or

* The electron microscopic studies were carried out while Dr. Reed was on the staff of the Department of Biomolecular Structure of this University, and the authors would like to thank Prof. W. T. Astbury for the facilities provided.

treatment with performic acid at 18° C., can be used for the production of similar soluble proteins and that, in addition, polysaccharide and sulphuric acid are liberated.

Elastin can be digested by the enzyme elastase[13]. Our initial observations appeared to preclude the existence of a component common to all elastic tissue since there was a gross difference between the susceptibility of human aorta and ox ligamentum nuchæ to attack by the enzyme. Little, if any, of the ligament was dissolved at *p*H 10·3 and under the conditions described as optimum by Balo and Banga[14]. We have shown that this phenomenon is due to inadequate buffering. Appreciable quantities of sulphuric acid are liberated by the action of elastase on human tissue, especially at high *p*H values, whereas over a similar range of *p*H the amount of acid released from ox ligament is much less. Given adequate buffering, it has been shown that elastase has the same shape of *p*H sensitivity curve for both substrates with an optimum *p*H value of 8·55. The amount of acid liberated from aortic tissue under conditions of inadequate buffering at an initial *p*H of 10·3 was sufficient to lower the *p*H to the optimal value of 8·55, whereas with the ligament an initial *p*H of as low as 9·5 was needed before the required depression could be attained. The quantity of acid liberated was directly proportional to the amount of elastin passing into solution during the dissolution of the first half of the tissue. At this point, however, the whole of the acid had been released and the remaining protein passed into solution without any further lowering of *p*H.

Collagen-free human elastin preparations, treated with urea to remove the extra component, show progressively increasing susceptibility to enzyme attack. With a concentration of urea suboptimal for solution it is possible to remove the extra component without affecting the solubility of the remaining elastin. Material which has been completely taken into solution by means of urea, and then reprecipitated from solution by acetone, shows a far greater rate of dissolution under the action of elastase and a marked increase in its degree of solubility in buffer solution. Ox ligament, which dissolves in urea solution over a much shorter time range, shows little increase in susceptibility to elastase until final solution occurs.

Before discussing the possible structure of elastic fibres we would direct attention to the following observations :

(1) The soluble proteins obtained from elastic tissue by all the chemical methods show the property of reversible heat denaturation ; but the soluble protein produced by the action of elastase does not.

(2) Amino-acid analysis of the proteins obtained from both aortic and ligament tissues, either by treatment with urea or oxalic acid, are similar to the previously accepted values for 'elastin'.

(3) Urea solutions of elastic tissue contain no free amino-acids, but such compounds are present in oxalic acid solutions.

(4) Polysaccharide and sulphuric acid are liberated by the action of those reagents which produce the soluble protein material.

(5) The action of elastase on human aortic tissue and on ox ligamentum nuchæ is similar from a morphological point of view. Fine fibrils are embedded in an amorphous cement substance in both tissues, and removal of the latter results in the collapse of the structure.

(6) Solutions of elastic tissue in urea show low viscosity and no streaming birefringence, hence they may contain a corpuscular unit similar to the G-elastin postulated by Banga[15].

(7) The total amount of polysaccharide in the tissues is small, approximately 2 per cent in aorta and 0·5 per cent in the ligamentum nuchæ.

It is therefore reasonable to suppose that part at least of the elastin system is made up of linear aggregates of a corpuscular protein unit of low molecular weight. To this extent we agree with Banga[15], who considers that fibrils of elastin (*F*-elastin) are built up from repeating units of *G*-elastin, entirely analogous to the *G*–*F* transformation of the muscle protein actin ; but so far there is no evidence to identify the hypothetical *G*-elastin with the units we have observed. Moreover, Banga's concept of *G*- and *F*-elastin precludes the involvement of such units in mixed mucoprotein chains (see below), and therefore we think it inadvisable to use the name *G*-elastin for these structural units. On the other hand, to use the name elastin would be equally confusing, since the word has a different meaning for the chemists and for the histologists. We suggest as a temporary expedient that these corpuscular units should be proelastin, analogous to procollagen[16], the soluble protein derived from collagenous tissues. There is, however, as yet no evidence that proelastin exists in the free state in elastic tissue.

The main difference between our observations and those of previous workers is the finding that polysaccharide and sulphuric acid are intimately associated with protein in elastic tissue. It is significant that polysaccharide is liberated simultaneously with protein whenever the tissue is degraded, and this points to the association of acid, polysaccharide and the proelastin as being a necessary condition for tissue stability. To postulate linear chains of polysaccharide arranged in parallel association with aggregates of proelastin would be more in accord with present knowledge of muco-protein systems ; but it is difficult to see how such an arrangement could bring about the high degree of stabilization observed. As a possible explanation we would suggest the presence of mixed mucoprotein chains each of which is formed by proelastin units joined by polysaccharide molecules and that these chains are essentially the stabilizing cement material surrounding chains of linearly aggregated proelastin. A suitable name for this species would be elastomucin. In our view, therefore, elastic staining tissue consists of linear aggregates of proelastin protected by material consisting of similar units held together by union with polysaccharide. The ratio of polysaccharide to proelastin has not yet been determined accurately, but five moles of acid including both sulphuric and possibly uronic acids are associated with each proelastin unit.

The dual nature of elastin seems to follow from the fact that during the action of elastase all the acid is liberated during the dissolution of only half the protein. It also accounts for the presence of amorphous and fibrous material as revealed by the electron microscope.

The doubt expressed by Banga[15] as to the function of elastase is substantiated by our observations. We suggest that elastase is not a proteolytic enzyme, but rather a mucase. It would therefore attack only the elastomucin chains liberating the proelastin therefrom. Once the stabilizing effect of this elastomucin is removed, however, the remaining proelastin would be released by direct solvation from the chains con-

taining no polysaccharide. This mechanism would account for the liberation of all the acid during the first half of the enzyme reaction and, if the fine fibrils observed in the electron microscope during the initial stages are aggregates of pure proelastin, would also explain their rapid disintegration. Proteolytic enzymes such as trypsin which have been shown to digest elastic tissue after prolonged treatment must be assumed to attack the proelastin units themselves.

The proposed structure would also account for the liberation of protein units of similar properties by the prolonged action of reagents such as alkali and performic acid, capable of disrupting the polysaccharide, since similar units of proelastin could originate from both the cement material and the fibrils. A reagent favouring polypeptide hydrolysis such as oxalic acid would be expected to have a different action, as indeed is the case. Chemical reagents might be more drastic in their removal of polysaccharide than the enzyme, and the retention of sugar residues masking the ends of the proelastin from the cement material, in the case of protein solutions prepared by elastase, could preclude the thermal denaturation of the whole preparation.

Thus we suggest that there is considerable evidence in favour of the existence of two common entities in the elastic staining fibres of human aorta and of ox ligament.

The polysaccharide– elastomucin—content of aorta is higher than that of ox ligamentum nuchæ, and this finding is supported by the presence in the aorta of sheets of amorphous material at the e.m. level and of the lamellæ at the light microscope level. The smaller concentration of elastomucin in ligament would explain the more rapid rate at which this tissue finally passes into solution, since little mass would be dissolved during the earlier removal of the cement substance. Schultz[17] in 1922 suggested that the staining capacity of elastic tissue was due to the impregnation of elastin by mucin, which he identified as the 'chromatropic ground substance' present in many tissues. Our proposed structure gives a rational foundation for these deductions which were based solely on histological observations.

Whether any enzyme function is associated with the linear aggregation of proelastin, as is the case with actin, is unknown. It is significant, however, that Banga and Nowotny[18] have reported the presence in aortic tissue of an ATP-ase different from the muscle enzyme and which falls in amount as the elastin content of the aortic media decreases with increasing severity of arteriosclerosis.

A knowledge of the structure of elastic tissue is essential for an understanding of clinical problems. Balo and Banga[19] have applied their studies of elastase action to the problem of arteriosclerosis and have suggested that the degeneration of human elastic tissue is brought about by the enzyme elastase, which they had shown to be present in beef pancreas. Further, the enzyme was thought to be controlled by an inhibitor present in the sera of normal persons, but absent from those of patients with vascular degeneration. We have been unable to obtain elastase from normal human pancreas processed in an identical fashion to the hog and beef pancreas used for the routine preparation of the enzyme. This observation has been confirmed by a personal communication from Mr. E. Levin, of the Viobin Corporation, from whom the hog pancreas used in this work was obtained. It may be that, in the human, elastase is secreted in organs other than the pancreas, but it is more likely that the whole question of elastomucin involvement in arteriosclerosis is far more complex than that of a simple enzyme/inhibitor system, and more studies are needed, especially into the mucoid/protein interrelationship, in order to assess the changes involved in vascular degeneration. Again, in the present communication we have ignored the possible participation of lipoid as a tissue stabilizer, but in view of the changes associated with arteriosclerosis, no hypothesis would be adequate that ignored so important a factor.

We would like to register our indebtedness to Mr. T. J. Bowen for physical observations and to Dr. F. Wewalka, of the 1st Medical Clinic, Vienna, for help in some of the initial observations on the elastase reactions; also to Messrs. A. Millard and G. D. Coulson and Misses I. Rennie and B. Stannard for technical assistance. We also wish to acknowledge the gift of samples of elastase of high purity from Prof. I. Banga, Budapest.

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OBITUARY

Dr. J. C. James

John Charles James was born at Harrow in 1920. He passed through Harrow County School to Queen Mary College, London, where he took first-class honours in chemistry in 1940. After a period in the laboratories of the London Passenger Transport Board, he became a research student under C. W. Davies at Battersea Polytechnic (where he was made lecturer in 1945), and was awarded the Ph.D. degree by the University of London in 1947. Since 1948 he had been a lecturer in chemistry in the University of Glasgow.

Deriving from his training at Battersea, his earlier work, and most of his published work, involved the accurate measurement of electrolytic conductivities, from which were elucidated various ionic interactions in solution. During the past two years he had become interested in the polarography of non-aqueous media and in the double-layer capacity at electrode surfaces; he and his students were opening up several very promising lines of research in these related fields. James was an able and industrious experimentalist, ingenious in adapting electronic techniques to the

study of electrochemical problems. He had also recently collaborated in the first reliable determination of the dielectric constant of anhydrous sulphuric acid, proving this important quantity to be not much higher than that of water. Only the first-fruits of all this later work have yet been published.

Though of a quiet disposition, James was a good and witty lecturer, very popular with his students, and well liked by his colleagues. He was unmarried. His untimely death in a mountaineering accident in the Jotunheim, Norway, on July 9 is a great loss to electrochemistry in Britain. J. C. SPEAKMAN

NEWS and VIEWS

Parliamentary and Scientific Committee: Deputation to the Lord President of the Council

A DEPUTATION from the Parliamentary and Scientific Committee, including Lord Samuel (president), Lord Waverley (past-president), Sir Ralph Glyn (deputy-chairman) and Mr. M. Philips Price (vice-president), which waited on Lord Woolton, the Lord President of the Council, on July 28, while welcoming the indications in the speeches of Lord Woolton and Lord Cherwell in the debate in the House of Lords on June 11 that the Government recognizes the urgent importance of exploiting discovery and research as rapidly as possible and of a much closer liaison between science and industry, asked for further information as to the specific action the Government proposed to take in the immediate future, especially in so far as such action would make a valuable contribution to productivity and the balance of payments crisis. Further information was also requested as to the action the Government proposes to take to meet the very serious criticism of the last report of the Advisory Council for Scientific and Industrial Research, especially in regard to the recruitment of staff and the execution of the Department's Building Programme. In this connexion the Parliamentary and Scientific Committee urged that it was false economy to hold up essential developments in the country's scientific and technical resources. Research must be based on reasonably firm budgetary expectations for several years ahead, and sudden and unexpected limitations or cuts caused more than a proportionate retrenchment. The deputation also urged the extension of the co-operative research scheme to research in veterinary medicine and agriculture and asked for further information as to the steps to be taken to build up a technological institution of university rank and to increase the financial assistance available for selected technical colleges.

The deputation also indicated the Committee's strong endorsement of the main conclusions in regard to scientific man-power of the last report of the Advisory Council on Scientific Policy, and also represented to Lord Woolton that the facilities for the publication of original papers and abstracts in the field of chemical sciences also called for inquiry and action by the Government. Some replies received in reply to a question as to the extent to which industry made effective use of the results of scientific research and any obstacles to the utilization thereof, included in a questionnaire circulated by the Committee prior to the House of Lords debate, suggested that the absence in Britain of an efficient abstracting journal or journals was a major obstacle and that there was a case for further support from the Government for scientific publication generally. Defective liaison services, the lack of trained men both on boards of directors as well as in production, difficulties experienced in obtaining licences and delivery of items of plant, financial problems arising out of plant obsolescence and taxation policy were also contributory factors, as well as the general backwardness of some industries. Lord Woolton expressed his keen interest in the points raised and promised to give them careful consideration.

Wool Industry Research Levy

AN Order increasing the wool industry research levy was approved by the House of Commons on July 24. The amount of the levy depends on both the employment in the industry and its consumption of raw material. Both have declined, and the increase has been requested by both sides of the industry, by the Wool Textile Delegation and by the National Association of Unions in the Textile Trade, and it was estimated by the Parliamentary Secretary to the Board of Trade that the amended rate would have yielded £70,000 in place of the £48,000 actually collected during the first six months of this year or the £114,000 produced by the first year of the levy approved in October 1950. Of the £48,000 collected this year, £31,000 was based on the employment unit and £17,000 on the supply and consumption of fibre. The Parliamentary Secretary expressed himself as satisfied with the programme of research conducted by the Research Association and stated that the £100,000 required to qualify for the grant from the Department of Scientific and Industrial Research was regarded as adequate for the programme in mind. Some concern as to the value of that programme was expressed in the debate, notably by Mr. Mikardo, who urged that the most forward-looking and imaginative research was being done not in the Research Association establishments but in industry. He questioned whether the research association was devoting sufficient attention to what he called the fundamental problems of the industry, and asked whether the distribution of expenditure on research between the research association, the universities and the technical colleges was that most appropriate to enable the industry to make the best use of scientific knowledge. Mr. Mikardo was as concerned as other speakers in the debate that there should be adequate expenditure on research and the fullest possible utilization of its results by the industry. The distribution of research effort is not a matter for the Board of Trade, however, and Mr. Mikardo scarcely made his case sufficiently specific to warrant the Department of Scientific and Industrial Research setting up a further survey panel from what he said alone.

United Nations Resolution on Indigent Aliens and Refugees

ON August 9, 1951, at its thirteenth session, the Economic and Social Council of the United Nations adopted a resolution directing attention to the report on assistance to indigent aliens prepared by the Secretary-General at the Council's request and re-affirming its recommendation that governments

should not expel or deport aliens solely on the grounds of indigency or becoming public charges. The resolution recommended governments to accord to aliens lawfully in their territory the same measures of public assistance as are accorded to their own nationals and to give effect to the principles enunciated in the Secretary-General's report in any legislation or administrative action required. The Department of Social Affairs of the United Nations has now issued a pamphlet entitled "Study on Assistance to Indigent Aliens" (pp. 81. New York: United Nations. London: H.M.S.O., 1952. 50 cents or 3*s*. 9*d*.), and this publication embodies the analysis and conclusions contained in the Secretary-General's report as well as some current data and information. Besides the general conclusions drawn from the survey, which led to the resolution already quoted, those reached by the Social Commission and the Economic and Social Council are also indicated. Appended are the texts of some existing conventions or agreements, including the Model Convention on Assistance to Indigent Aliens approved by the Council of the League of Nations in May 1938, the Convention which was concluded between Denmark, Finland, Iceland, Norway and Sweden in January 1951, and that on the Status of Refugees adopted by a United Nations conference on July 25, 1951.

Survey of Physiology in the United States

The American Physiological Society, under contract by the National Science Foundation, is undertaking a study to determine the present status in the United States of research and education in physiology, including an inventory of available scientific workers, facilities, and institutional and communication problems, and an appraisal of how progress in physiological research relates to other scientific fields and the national welfare. The project has been sponsored by the Foundation, partly because of the central importance of physiological research to all sciences, but primarily to test the value of such a survey-inventory in assisting the Foundation in developing a national policy for science and research in the United States. The contract will be administered for the Foundation by Mr. John Field, assistant director for biological sciences. The survey-inventory will be conducted in two parts, the first being a pilot study, which has already begun and is expected to last for seven to nine months, and from this will be developed the pattern for a more detailed full-scale investigation, which, it is anticipated, will last for an additional eighteen months. The full-scale study will include such problems as the historic development of physiology as a science, present conditions and trends, research and educational facilities and personnel, and the policy for the dissemination of information, communication and publication in physiological work. The pilot phase of the study, costing 33,500 dollars, is under the direction of an honorary central committee, appointed by the American Physiological Society, and the committee has appointed Dr. Orr E. Reynolds, on leave of absence from the Office of Naval Research, to serve as executive director on the pilot project.

Moving a Factory

Mr. Roy Lewis, joint author of the recently published highly successful book "The English Middle Classes", has written a fascinating account of the resettlement of a factory and its workers in the first of Britain's new towns. The factory, Sunvic Controls, Ltd., was formerly housed in a "warren of workshops" in Long Acre, Covent Garden, and was rapidly developing the highly skilled business of producing instruments for temperature, electrical and other forms of control. With the rearmament programme, expansion of facilities became essential and urgent in the nation's interest. A new factory was needed; but it was essential to keep at least a nucleus of the skilled staff together. In Harlow new town the requirements were ideally met; the Development Corporation was glad to get a rapidly developing business for its industrial estate. The directors of Sunvic wished to move the whole factory from Long Acre to Harlow, and put the proposition to the staff. Despite many obstacles about 70 per cent of them elected to move and, in his booklet, Lewis describes how these and unexpected difficulties were overcome, how personal problems were resolved and a new team spirit at Harlow was created. The booklet, which may be obtained from Sunvic Controls, Ltd., No. 1 Factory, Harlow, Essex, admirably describes a sociological experiment which is of the greatest significance in the re-distribution of urban populations from over-crowded cities.

Aslib: Report for 1951

The annual report of the work of Aslib for the year ended December 31, 1951 (pp. 22; London: Aslib, 1952), records an increase in membership from 1,038 in 1950 to 1,219, the largest percentage increase—thirty—being in the industrial and commercial membership. Besides the annual conference at Ashorne Hill in October, for which many applicants had to be refused, a successful conference was arranged by the Scottish Branch in May, and one arranged by the Northern Branch at Birmingham in June led to the inauguration of a Midlands Branch in September. The Northern Branch also arranged a successful meeting at Leicester, and six London meetings were held during the year. A number of special groups were also established during the year, covering aeronautical engineering, textiles, economics, and food and agriculture. The report includes an extended analysis of the work of the Information Bureau and Library, which handled 3,521 inquiries during the year, an increase of 33 per cent on 1950, apart from 1,236 loans from the Aslib library. Of these inquiries, 1,255 were requests for inter-library loans; and, of the 1,690 telephone inquiries, 464 were for complete bibliographical references of published works and 379 for locations, not necessarily for loans. Of 576 postal inquiries, the most numerous were for complete bibliographical references of published works or references on a specific subject (129 each) and for special library routines, training, etc. (106). By the end of the year, 3,500 translations had been recorded in the index of unpublished translations.

Petroleum Consumption and Refinery Production in Great Britain during 1951

The Petroleum Information Bureau (on behalf of the United Kingdom Petroleum Industry Advisory Committee) has released statistics of oil consumption and refinery production in Great Britain during 1951, which show an increase in total consumption of all products of 1,611,137 tons above that of the previous year. When it comes to output of finished products from the refineries, the figures are even more impressive: 16,430,025 tons in 1951, as against 9,283,752 tons in 1950. This actually reveals the intensive development of refinery capacity which has

taken place in the past twelve months or more in accordance with the refinery expansion programme in Great Britain. Production of aviation and motor spirit was 2,923,181 tons as against 1,477,955 tons in 1950; again, nearly half the output of refinery products was fuel oil—7,649,982 tons during 1951 and 3,805,198 tons during 1950. The refineries are processing almost entirely Middle East crude oil, thus saving dollar currency, and, in any event, the increased output represents a substantial saving in cost of the finished products.

Archæology in Greece and Cyprus during the Year 1950–51

THE survey, "Archæology in Greece, 1950–51", by J. M. Cook, to which is appended "Archæology in Cyprus, 1951", by A. H. S. Megaw, is published both in the annual report for the session 1950–51 of the British School of Archæology at Athens (pp. 60; from 9–13 George Street, London, W.1; 1952) and in *Journal of Hellenic Studies*, 52 (1952). The Second World War and its consequences have had one good effect in classical archæology, namely, that there has been less excavation and more study of what had already been excavated. Hence these two surveys, which are limited to field-work and finds of objects, are less sensational than sometimes in the past. The energetic Orlandos is repairing and restoring ancient and medieval buildings in many parts of Greece. The Americans continue their model exploration of the Agora (or public centre) of ancient Athens, the greatest and most solidly productive undertaking of classical archæology; it now seems that there is below the Agora a large cemetery of the Late Bronze Age. Of other excavations the most useful is that of Old Smyrna, where the Turks and British have found remains going back to the Early Iron Age; this is important for the date and nature of the Greek colonization of the coast of Asia Minor. Elsewhere, expeditions have produced finds interesting in themselves, but of less general relevance. There is still a tendency to excavate without good reasons; perhaps, in this respect, rising costs will prove a blessing.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: P. Adames (agricultural officer, Sierra Leone), principal agricultural officer, Sierra Leone; E. G. Giglioli (assistant agricultural superintendent, British Guiana), agricultural superintendent, British Guiana; T. S. Jones (agricultural officer, Sierra Leone), senior agricultural officer, Sierra Leone; C. H. B. Williams (deputy director of agriculture (crop husbandry), Trinidad), director of agriculture, Trinidad; A. Cawley (deputy director, Geological Survey, Nigeria), director, Geological Survey, Uganda; C. E. W. Hoar (pathologist, Nigeria), pathologist, Uganda; R. E. Alvares (assistant pathologist, Hong Kong), pathologist, Hong Kong; J. P. Henderson (meteorologist, East African High Commission), assistant director, East African Meteorological Department; P. I. R. MacLaren (fisheries officer, Nigeria), fisheries officer, Game and Tsetse Fly Department, Northern Rhodesia; Ong Chin Ghee (senior agriculture assistant, Sarawak), senior assistant agricultural officer, Sarawak; D. W. A. Peters (laboratory technician, Medical Department, Somaliland Protectorate), laboratory superintendent, Virus Research Institute, Nigeria; A. McCallum, agricultural officer, Tanganyika; A. J. Ouseley-Smith, agricultural officer, Uganda; Dr. H. J. F. Cairns, medical research officer, grade 3, Virus Research Institute, Uganda; P. J. Byrne, veterinary officer, Tanganyika; R. F. Apps, scientific officer, Royal Observatory, Hong Kong; J. A. C. Davies, agricultural officer, Sierra Leone; H. S. Deans, assistant conservator of forests, Jamaica; R. Good, educational psychologist, Northern Rhodesia; J. G. Halcrow, entomologist, Colonial Insecticides Research Unit, Mauritius; R. C. Jones, hydrologist, Public Works Department, Kenya; R. M. Mabon, laboratory assistant, Veterinary Department, Tanganyika; Hon. P. L. A. O'Brien, geologist, Northern Rhodesia; Miss J. M. Slow, scientific officer, Maize and Produce Organization, Kenya; Dr. L. A. Whelan, soil chemist, Agricultural Department, Kenya.

The Behaviour of Bower-birds

DR. L. HARRISON MATTHEWS writes: "The article on 'The Behaviour of Bower-birds' that appeared in *Nature* of July 19, p. 110, is based on a review by Prof. Evelyn Hutchinson, of Yale University, that appeared in the *American Scientist* (40, No. 1). The writer of the article in *Nature* does not make it clear that this is a review by Prof. Hutchinson of original work published by Dr. A. J. Marshall at various times in *Nature* and the *Proceedings of the Zoological Society of London*. Prof. Hutchinson gives due credit to the author of the papers which he reviews, but it should also be made clear to readers of *Nature* that the original work was done, not by Prof. Hutchinson, but by Dr. Marshall".

The writer of the article did mention that it was based on Prof. Hutchinson's review; but we regret that no reference was made to the original work by Dr. A. J. Marshall.

Announcements

DR. H. A. B. SIMONS has been appointed to the readership in physics tenable at the Royal Free Hospital School of Medicine, London, from October 1.

THE United States Government and the Institute of International Education are offering grants or supplements to existing grants for graduate study in an American university during the year 1953–54. Applicants must be citizens of the United Kingdom or the British Colonies, less than thirty years old, and must possess a bachelor's degree or its equivalent. Application forms (to be completed by November 1) can be obtained from Mrs. D. R. Dalton, Universities Department, English-Speaking Union, 37 Charles Street, Berkeley Square, London, W.1. Applicants from the British Commonwealth, other than those in the above category, should apply to the respective United States embassy in their own country for information on similar grants.

ERRATUM.—Mr. W. D. Furneaux writes that in his communication to *Nature* of July 5, p. 37, entitled "Some Speed, Error and Difficulty Relationships within a Problem-solving Situation", he has inadvertently omitted a t from equations (1) and (2), which should therefore read as follows:

$$P_S = \int_0^t \frac{1}{\sigma_S t\sqrt{2\pi}} \exp - (\log t - mD + S)^2/2\sigma_S^2 \mathrm{d}t \quad (1)$$

$$P_C = 1 - \int_0^t \frac{1}{\sigma_C t\sqrt{2\pi}} \exp (\log t - C)^2/2\sigma_C^2 \mathrm{d}t \quad (2)$$

LABORATORIES FOR CEMENT RESEARCH

THE new research laboratories of the Associated Portland Cement Manufacturers, Ltd., at Stone, in Kent, were opened on July 11 by the Minister of Works, the Right Hon. D. McA. Eccles. These laboratories, together with general offices, form a pleasant building, and the architects, Messrs. Westwood, Sons and Harrison, are to be congratulated on the effect of modestly decorating a functional building with Tyrolean and coloured finishes and by the occasional use of Kentish rag-stone.

In these laboratories and offices, a large staff of well-qualified scientific men and technicians will work towards the improvement of the quality of cement, the cheapening of production, and the introduction of new products, in addition to dealing with specific problems which continually arise. Engineering research in connexion with cement-making plant will form an important part of the work, as well as fundamental research in the chemistry and physics of cement manufacture, and its behaviour in the making and curing of concrete and many allied materials. The development and improvement of methods of manufacturing burnt clay, sulphate-resisting and low-heat cement are also important objects.

The laboratories are well equipped. The lay-out of the chemical laboratories is of particular interest. Artificial ventilation effectively disposes of fumes, and subsidiary side-rooms are provided to house such equipment as muffles, furnaces, hot plates, water-baths and additional fume cupboards, etc. The Physical Testing Department has the usual equipment for cement and concrete testing, including temperature- and humidity-controlled curing rooms. It is evident from results that when testing is carried out under rigorously controlled conditions the uniformity of strength of cubes is as good as can be desired when made from the same batches of cement.

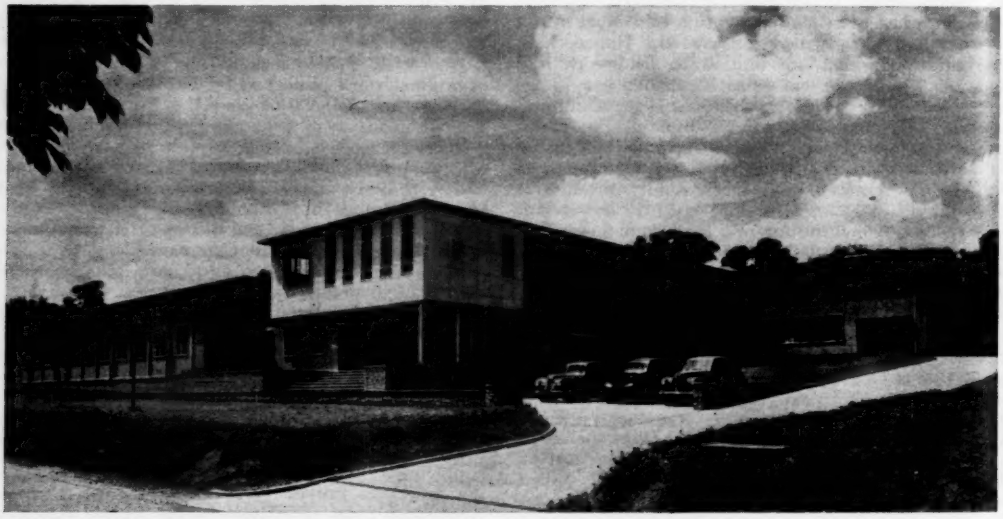

Fig. 1. Research Laboratories of the Associated Portland Cement Manufacturers, Ltd., at Stone

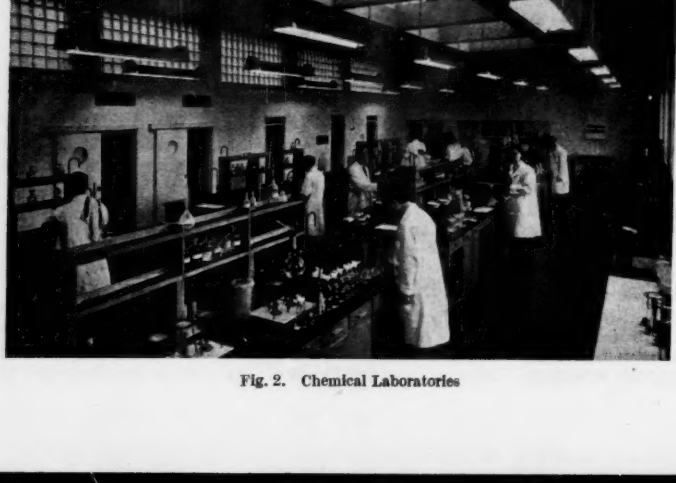

Fig. 2. Chemical Laboratories

It would take too much space to describe in detail all departments; but it should be mentioned that in the laboratories there is a Kilns and Mills Division, and a Raw Materials Section, both well equipped and doing important work. There is a Microscopic Department, and a Library is beginning to accumulate. There is a lecture room in which instruction is given to personnel undergoing training in cement technology. This activity is considered to be one of the most important functions of the laboratory. A large and pleasant canteen has been

provided ; in fact, the visitor receives the impression that every aspect of planning has been well considered.

The staff of the laboratory will no doubt contribute greatly in the future towards improvements in the cement industry, and so give further help towards the solution of some of our economic problems, to which the cement industry has already contributed much.

GERMAN SOCIETY FOR ELECTRON MICROSCOPY

FOURTH ANNUAL CONFERENCE

THE fourth annual conference of the German Society for Electron Microscopy took place this year at Tübingen during June 6–9. The increasing interest evoked by this event, both inside and outside Germany, may be judged by the attendance at the conference of more than two hundred electron microscopists, many of whom came from abroad. Although this was not an international conference, eight European countries were, in fact, represented. A high standard was maintained both in the papers presented and in the discussions. It was felt, however, that the total number of eighty papers was rather large considering the limited time available. It is only possible to mention a few of the papers here, and these have been chosen so far as possible to indicate the general scope of the conference.

The chairman of the Society, Prof. U. Hofmann, delivered the opening lecture, choosing as his subject "The Electron Microscope in the Treatment of Problems in Inorganic Chemistry". The electron microscope, he said, has made its contribution to organic chemistry largely by virtue of its ability to resolve fine structures, particularly those of crystals. It has been used, for example, for determining the structure of graphite crystals in connexion with problems of lubrication. Similarly, with its aid, progress has been made in the chemistry of soils and clays and in the selection of suitable fillers for rubbers. Although the resolving power of the electron microscope is not yet sufficient to resolve atomic structure, it is often possible to use the instrument for obtaining an estimate of surface area and crystal size, thus obtaining a valuable check on X-ray determinations from line-broadening measurements.

Several papers were devoted to the imaging properties of electron lenses. H. Bremmer developed a simple approximate formula for the axial field distribution in a magnetic lens in terms of the lens excitation and pole-piece geometry. S. Leisegang presented a theoretical paper on the form of the caustics arising in lenses suffering from astigmatism. Previous work by W. Glaser and E. Regenstreif was reviewed, and a number of caustic cross-sections were shown arising from different types of field asymmetry. By observing such caustics in a lens provided with a suitable correcting device, it is possible in principle to compensate the lens astigmatism.

F. Lenz and M. Hahn showed how this could be done experimentally. Electrons are arranged to travel through an astigmatic lens in slightly under-telescopic ray-paths. The emerging electrons strike a distant fluorescent screen forming a pattern there, consisting of an astroid surrounded by a circle. Using Sturrock's theory of the astigmatic lens, Lenz and Hahn have correlated quantitatively the dimensions of this pattern with the asymmetries of the pole-piece system. Experimental results were shown for a particular magnetic lens in which the astigmatic difference of foci goes through a minimum value as the lens excitation is increased from zero to the maximum value available.

B. Von Borries, F. Lenz and G. Opfer described some experimental work undertaken to resolve a discrepancy amounting to 10 per cent between the focal lengths of a magnetic objective lens as calculated by Lenz and those measured by E. Ruska. Ruska's measurements were repeated and found correct. Further experiments on the magnetic circuit showed that, due to the design of the iron casing of the lens and to the B/H properties of the iron used, a loss of magnetomotive force of 5 per cent occurred, causing an increase in focal length of 10 per cent above the calculated value. This accounted for the discrepancy.

R. Seeliger reported progress in the attempts to construct an electron microscope in which the primary spherical aberration is eliminated using correction methods proposed by Scherzer. The mechanical and electrical stability of the instrument has been considerably improved, and the complete correction of primary spherical aberration has been realized. There are, however, many practical difficulties still to be overcome in connexion with the stability of the specimen, etc., before the greatly increased theoretical resolving power of the lens system can be fully attained.

A new approach to the problem of reflexion specimens for the electron microscope was put forward by G. Möllenstedt and H. Düker. Measurements of the velocity distribution of secondary electrons leaving a surface which is subjected to ion bombardment showed that the energy spread was only 3 eV. In the new microscope a metal specimen is placed at right angles to the optical axis and is bombarded with low-voltage ions by means of an ion source mounted at an angle of 45° to the specimen. The resulting secondary electrons are imaged at the fluorescent screen by an electrostatic lens placed immediately below the specimen. An accelerating voltage of 30 kV. is employed. The image has the appearance of that due to a shadowed specimen owing to the inclination of the ion source, thus facilitating the interpretation of the pictures. The resolution is at present about 1000 A. ; but it is believed that this can be improved considerably. The defects associated with previous systems employing glancing incidence at the specimen, namely, gross distortion of the field and high chromatic aberration, are avoided.

L. Wegmann outlined the design of a new Trüb–Täuber electron microscope which embodies several novel constructional features. An electrostatic objective and first projector lens are used, only the final projector being magnetic. The lenses are mounted on a hinged door provided with a vacuum seal. This construction makes the lenses readily accessible. In addition, the projector lenses are mounted on bearings so that they may be swung out of the path of the beam when a direct diffraction pattern is required. Two ranges of magnification are provided : 800–4,000 for comparison work with the optical microscope, and 8,000–14,000. A focusing aid is incorporated which causes three images of each object point to appear when the instrument is incorrectly focused. This is achieved by providing two extra-axial holes in the condenser aperture in

addition to the normal central one. In ordinary use the illuminating beam passes through the central hole only; but, by switching in an A.C. deflexion system, the illuminating beam traverses the outer holes as well, giving rise to three images on the screen when the objective lens is defocused.

E. Kinder discussed the design of small microscopes. He gave his opinion that there is a place for a small microscope with a resolution of 100 A. and a magnification of 3,000. It should be provided with a transparent screen and pocket magnifier. The cost should be one-fifth of the price of an instrument having a resolution of 20 A.

The fluorescent screen received its share of attention. H. Arend, E. Ruska and I. Broser described quantitative measurements on the resolving power and light-conversion efficiency of a number of fluorescent screens. Their apparatus allows eight fluorescent screens to be viewed consecutively by either an optical microscope or a photomultiplier, without breaking the vacuum. A series of curves showed the effect of grain size and screen thickness on light output for both reflexion and transmission screens.

Dealing with the subject of electron diffraction, A. Boettcher and R. Thun described a dynamic electron diffraction apparatus in which phase changes in a specimen can be recorded on a single photographic plate. The instrument resembles the ordinary diffraction apparatus but is provided with a slit in front of the camera. This slit selects part of the ring diffraction pattern across a diameter. The specimen is heated up and the plate is traversed horizontally, thus producing a set of diffraction patterns corresponding to a given range of temperature. In this way, phase changes occurring in as short a time as fifteen seconds have been recorded. By using specially prepared alloy specimens, phase diagrams can also be obtained for simple alloy systems.

In connexion with the use of the electron diffraction camera, O. Radczewski outlined recent progress in interpreting the patterns obtained when investigating the structure of minerals.

Among many papers on the application of the electron microscope, only a few can be mentioned here. M. Fahnenbrock and W. Liese have investigated the mechanism of liquid flow control in the pores of certain conifers, using a 'Perspex' replica method with silicon monoxide shadowing. They have succeeded in building up a fairly complete picture of both the fine and gross structure of these pores which are several microns in overall size. These pores contain a central membrane carrying a central torus. In order to resolve the fine structure an electron microscope is needed. This paper was typical of many in which the higher resolving power of the electron microscope is used for building up a complete picture of comparatively large structures previously investigated with the optical microscope.

At the conference considerable importance was attached to the question of the falsification of object detail introduced by the preparation technique. E. Perner and G. Pfefferkorn described critical comparisons they had made on the effect of methods of specimen preparation for the electron microscope on plant chondriosomes. Micrograms obtained in the electron microscope were compared with those obtained directly using an optical phase-contrast microscope. Considerable differences in shape and structure were apparent. The authors concluded that this was due to the homogenizing and fixation technique, and were of the opinion that preparation methods which had proved successful for animal structure could not be applied to botanical material.

Of no less importance are the changes that occur in the specimen material due to the electron bombardment. A. Brockes, M. Knoch and H. König reported further measurements on the variations that occur when polystyrene latex and nitrocellulose are bombarded with electrons. It was stated that an electron 'dosage' of only 1×10^{-3} coulombs/cm.^{2} is sufficient for detectable changes to occur in nitrocellulose, 4×10^{-3} coulombs/cm.^{2} being the corresponding dosage for polystyrene latex. This corresponds roughly to only one or two electrons per square angstrom at the specimen.

L. Wegmann showed examples of specimen damage by comparing micrograms taken with object loadings of 2,000 and 10,000 W./cm.^{2} respectively. The use of beam-limiting apertures was suggested to limit the area of the specimen being irradiated.

It may be remarked here that the question of specimen contamination, that is, the formation of a visible deposit on the specimen at somewhat higher dosages, received very little attention in comparison with the variations that occur in organic material.

Several speakers dealt with the detection of defects which frequently occur in crystals. R. Bernard and E. Pernoux gave examples of the *Schlieren* effects that arise in the imaging of very thin crystals in the electron microscope. G. Möllenstedt, and also O. Rang, showed how the size and position of cavities and other defects in crystals can be determined by correlating a particular electron diffraction pattern quantitatively with the corresponding area of the specimen. This is done by selecting a particular ray from the diffraction pattern, by means of an aperture, and using it to form a focused image of the corresponding area of the specimen.

The advantages of stereoscopic methods were emphasized by R. Rühle and E. Zehender. The special object-holder employed in the Bosch electron microscope enables the operator to rotate the specimen through 25° without appreciable transverse object movement. In this way a good idea can be gained of the surface contour of the specimen before a photograph is taken. A short film was shown of the appearance of the image as the object is rotated.

J. Helmcke and B. Jahn demonstrated by means of stereoscopic projection the structure of the dentine canals in human teeth.

V. C. Dalitz and J. A. Schuchmann reported on their work in developing the 'carbon' skin replica method described at last year's conference by König. J. Helmcke had used a somewhat similar technique to investigate the fine structure in thick membrane films.

Other speakers dealt with the preparation of textural components in steels and the application of the point emission microscope to metallurgical problems. Papers were given on the investigation of colloidal fractions of the soil, methods of preparation of bacteriophage, and the examination of plant cells with the aid of the microtome.

Electron microscopy in the U.S.S.R. was reviewed by F. Lenz. He stated that most of our information is based on the proceedings of a conference on electron microscopy held in Moscow in 1950. There are more than a hundred Russian-built electron microscopes in the Soviet Union using magnetic lenses. The design follows closely that of the Siemens instrument. There are also a number of electrostatic instruments.

Most of these instruments are operated on behalf of the electrical industry. Research is being carried out on the imaging properties of electron lenses, and the production of high voltages using high-frequency oscillators. Investigations are being pursued into the scattering properties of electrons and the interaction of electrons and the photographic plate.

An exhibition of photomicrographs was held illustrating the topics dealt with at the conference, and interesting large-scale demonstrations of optical diffraction effects were given by Prof. Kossel.

T. MULVEY

PRIMITIVE MEDICINE AT THE WELLCOME HISTORICAL MUSEUM

ON July 18 the new exhibition at the Wellcome Historical Medical Museum, 28 Portman Square, London, W.1, which bears the title "The Medicine of the Aboriginal Peoples in the British Commonwealth", was officially opened, and on that occasion Lord Webb-Johnson delivered an address. In his introductory remarks the director of the Museum, Dr. Ashworth Underwood, explained that the scope of the exhibition has been restricted to the primitive races in the Commonwealth in order to enable the subject to be covered in the limited space available; this arrangement nevertheless allows of a cross-section of the world to be illustrated.

The exhibition is divided into a number of sections which lead from general primitive conceptions, through ideas regarding the nature of disease, to its treatment by non-rational and by rational methods. The sequence then follows the detailed methods used in treatment, and the practices which are employed for the protection of the individual, both against disease and danger in general, and also against specific ailments.

In the section dealing with general knowledge various fine carvings, such as a genealogical stave, should be mentioned. In the section dealing with the cause of disease, attention should be directed to the fine series of sago-pith effigies from Borneo, to the various memorial heads, the finely carved soul-catchers, and to the unique exhibit illustrating the cult of the god of smallpox in the Yoruba mythology. The practice of the medicine man himself is well illustrated, and the very complete outfits actually used by certain individual medicine-men will be of the greatest interest. This section contains a number of fine carvings, especially the spirit-masks and the front-pieces of ceremonial head-dresses.

In the section dealing with treatment, attention should be directed to the outfit actually used by the personal medicine man to Cetewayo, which contains a number of horns used for cupping purposes. The various instruments and operations shown in the section on surgery illustrate the ingenuity of primitive peoples in making very simple instruments serve a specific purpose. The practice of artificial deformation is illustrated by some most interesting specimens, including a rare preserved head showing the practice of elaborate facial tattooing which, among the Maori, was reserved for chiefs and other important persons.

The ritual background on which primitive medicine rests is shown by a number of most interesting carvings, some of which are used as masks in the ceremonies of various secret societies. These exhibits cannot be easily described; but attention should be directed to the very fine carved elephant's tusk from Benin which epitomizes so much of the background of African ritual and legend.

All the exhibits in this exhibition are selected from the collections in the Museum. The exhibition deals with subjects which are little known, and the detailed catalogue includes the fruits of extensive research. The catalogue is published by the Oxford University Press* on behalf of the Museum.

* "Catalogue of an Exhibition illustrating the Medicine of the Aboriginal Peoples in the British Commonwealth." Pp. xviii+58+6 plates. (Published by the Wellcome Historical Medical Museum by Geoffrey Cumberlege, Oxford University Press.) 3s. 6d.

SOUTH-WESTERN NATURALISTS' UNION

CONFERENCE AT PLYMOUTH

THE South-Western Naturalists' Union held its annual Whitsuntide conference during May 30–June 2 at Plymouth, at the invitation of the Plymouth and District Field Club and the Plymouth Institution. Some eighty members attended.

On May 30, the Mayor of Plymouth (Alderman H. Wright) received the delegates and members at the City Art Gallery. Afterwards Mr. H. G. Hussell showed a series of films illustrating the animal and plant life of the neighbourhood.

Most of Saturday, May 31, was taken up by a river excursion up the Tamar as far as Calstock. Mr. G. M. Spooner pointed out features of interest along the route; in the afternoon Cotehele House, formerly owned by the Earl of Edgecombe and now in the possession of the National Trust, was visited.

In the evening, Mr. Mervyn G. Palmer gave his presidential address; his subject was "Lundy". In his comprehensive survey of the island, he dealt with the geology, topography and history of Lundy and with its animal and plant life, paying particular attention to the birds.

A coach tour across the southern part of Dartmoor occupied most of June 1, and the hut circles at Grimspound and the stone avenue and menhirs at Merrivale were visited. Mr. Spooner again acted as leader.

The annual general meeting, following a meeting of the Council of the Association, was held on June 2. In his report, the honorary secretary, Dr. Stanley Smith, stated that at the present time the Union embraces twenty-two societies, one institution and one private member. A letter from the honorary secretary of the Ilfracombe Field Club inviting the South-Western Naturalists' Union to hold its next conference at Ilfracombe was then read, and the invitation accepted. Mr. Mervyn Palmer agreed to continue in office as president for another year, and the other officers were all re-elected: *Hon. Secretary*, Dr. Stanley Smith (University, Bristol, 8); *Hon. Assistant Secretary*, Miss Elizabeth Fleure; *Hon. Treasurer*, Mr. H. W. Turner; and *Hon. Auditor*, Dr. F. S. Wallis, Mr. G. M. Spooner, Mr. G. Tipper and Mr. O. G. Watkins were added to the Council.

On behalf of everyone present, Mr. Palmer thanked the Plymouth societies for their hospitality and all individual members of the Plymouth and District Field Club and Plymouth Institution who had contributed to the success of the conference. He particularly mentioned Mr. O. G. Watkins, who had

carried out the duties of local secretary, and Mr. Spooner, who acted as leader in the field.

Members had the choice of one of three excursions on the afternoon of June 2: a visit to the Aquarium and Laboratory of the Marine Biological Association; Buckland Abbey; and Plympton Castle.

SOVIET FAMILY LEGISLATION

CONSIDERING the concept of the family in Soviet life Dr. R. A. J. Schlesinger suggests that the U.S.S.R. does not just represent an attempt at the application of socialist theories in a modern industrial society. In considering any matter in the U.S.S.R. it should be realized that it is not a country but a continent; at the time of the Bolshevik revolution Russia comprised a greater variety of civilizations than it does at present, after a systematic process of industrialization (*Health Educ. J.*, 10, No. 2; April 1952).

In some areas until quite recently millions of peasant homes in Russia were man-dominated in the most brutal sense of the term, and women's condition deteriorated, at least in the poor peasant's home when the economic differentiation in the village increased its dependence on the richer neighbour. Of the Islamic regions some—especially the Volga Tartars—were fairly advanced; but most of them (especially Central Asia) belonged to the most backward provinces of the Islamic world. There were large areas over which a primitive tribal organization was still in operation. As late as 1936 the Government struggle against blood-feud was just in its concluding stage. Large sections of the penal codes of the Republics concerned dealt with paying bride-price, abducting women, polygamy, marriage of minors and similar "offences originating from tribal custom", some of which (for example, marriage of minors) came under heavy penal sanctions only if they were caused by local custom which the legislator wished to repress in the interest of the emancipation of women.

Confronted with the initiation of a revolution in human relations against the prejudices of primitive custom, the Soviet state has firmly kept to the Marxist concept that undesirable phenomena in family life should, and can, be overcome by the removal of their economic causes. In 1935 Stalin hailed the Labour Day as the great emancipator of peasant women because it granted them an income independent of that of their menfolk. To-day the Soviet Government is attempting to construct a modern industrial society in which its policies aim at stabilizing family relationships in such a society.

Before this were possible, however, certain 'house-cleaning' had to be concluded. In the 'house-cleaning' programme the first enactments of the revolutionary Government did not exceed measures current in modern legislation elsewhere. They were revolutionary only in comparison with Tsarist Russian legislation and consisted of such measures as the transfer of marriage and divorce from the Church to the registrar's office, admission of divorce on the joint petition of both parties, or by court decision on the petition of only one party, the decision being left to the judge's discretion.

Much confusion about the real social situation has been created and is still being created by exaggerated emphasis on some literary pronouncements. Even in statements by authors who must be regarded as characteristic of the Soviet outlook, concepts of an eventual withering away of the family played a predominant part. The withering process, however, always referred to the family as an economic unit of consumption and as the main place of education, and not as a normally permanent union of man and wife. To some extent this may have been due to the impact of the more Utopian elements of Marxist ideology, to some extent to exaggerated estimates of the potentialities of some measures which are clearly necessary in order to enable women to take their share in production, such as crèches, pre-school education and public canteens.

This view has now completely changed and, in all Soviet publications since 1936, the family is described with great fervour as "the primary unit of our Soviet society". The Ministry of Education publishes a special monthly, *Family and School*, to promote collaboration between home and school and the activities of parents' committees. Great emphasis is laid upon the responsibilities, not only of parents towards their children, but also of the younger members of the family towards the aged ones. The reasons for this change are political as well as economic.

After having passed its revolutionary period—which, *a posteriori*, is explained by the consideration that it was necessary in order to break up some millions of unfree relationships and to establish the principle of equality of the sexes—Soviet legislation, as enacted in the period 1936–45, has come to conclusions very similar to those current in other advanced industrial countries. Most of the differences may be explained by the absence of traditional prejudice; the Soviet State can leave the decision upon whether a divorce should be granted or not to the judge's common sense, without binding him by enumerating grounds for divorce, the presence of which gives a claim to, and the absence of which excludes, granting of a divorce. It can also encourage marriage without paying tribute to the concept that being an unmarried mother is morally wrong.

In essence, however, the conclusions arrived at are the same: marriage is the normal way to motherhood; the family home is the ordinary, though not the only, place to rear the new generation; men and women have equal rights within the family as well as in professional life. The real problems of the Soviet approach to the family arise less from the consummation of the permanent results of the feminist movement than from the potential contradiction between the recognition of the family home as one centre in the education of the future citizen and the demand for the access of women, not only in theory, but also in practice, to all professions for which they are physically fitted.

INHIBITION OF ŒSTRUS BY CULTIVATED GROMWELL

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IN one settlement of the Shoshone Indians, infusions of the roots of *Lithospermum ruderale*, Dougl., taken orally, were believed to have contraceptive properties[1]. Prompted by this, Cranston[2] administered fluid extracts of the herb to mice in their food. She observed inhibition of œstrus and fertility during treatment, without any evidence of general toxicity.

Other workers confirmed these findings and also extended them by showing, for example, an inhibition of certain mammary tumours[3,4]. We have observed a complete inhibition of œstrus in mice of the *C3H* strain by aqueous extracts of *Lithospermum ruderale* administered daily for four weeks.

Lithospermum ruderale is not readily available and batches of this plant vary greatly in activity. However, we have found that English gromwell (*L. officinale* Linn.), which can be cultivated, yields œstrus-inhibiting extracts.

Cultivation. Seeds of wild gromwell were sown in February under glass, pricked off in 3-in. pots at the end of April, and planted out in May in open limed beds. Plants, including roots, were harvested in October.

Stabilization. We found that delay in processing or slow drying of wild plants tends to result in loss of activity. The cultivated plants were therefore dried at 60° C. immediately after harvesting. This procedure effected stabilization.

Preparation of extracts. The dried plants are finely ground and the powder is extracted with cold distilled water for 45 min. After filtration, the residue is re-extracted with water at 60° C. The second extract is cooled, combined with the first and freeze-dried, since there appears to be loss of activity in aqueous solutions even when they are stored in the cold.

Administration to mice. Tests were made on mature female mice of the *C3H* strain with high œstrous frequency, established by daily vaginal smears during a preliminary period of at least seven weeks. They received daily, by stomach tube, freshly made aqueous solutions of the freeze-dried extract. After preliminary experiments with herb-diet mixtures, this method of administration was adopted because of the uniformity of dosage and the avoidance of complicating factors such as reduced food-intake[4] and inactivation on standing. Smears were taken daily and showed that the equivalent of 1 gm. of the ground dried herb inhibited œstrus, cornification remaining in abeyance from the third day after beginning of treatment until four to five days after its cessation. There is, however, considerable variation in the dosage response; for example, reduction of the initial dose of 1 gm. to 0·5 gm. herb-equivalent daily may maintain inhibition of œstrus. No toxic or other side-effects were noted. After termination of treatment, the œstrus rhythm returned to normal within three days.

Administration to human subjects. Although gromwell has long been used as a medicament and for preparing a popular beverage, no ill-effects have been reported. The observations in mice also suggested that experiments in human subjects were permissible. Preliminary experiments were thus made with the small quantities of extracts available.

(*a*) Single doses of active aqueous extract corresponding to 10 gm. of dried herb per day evoked no subjective effects or obvious objective effects in three subjects (two women, one man).

(*b*) A nulliparous woman aged thirty-four consumed, from the first day to the seventh day of the menstrual cycle, freeze-dried extract, equivalent to about 20 gm. dry herb per day; from the eighth day of the cycle until menstruation the daily dose was doubled. Indices of ovarian function, both œstrogenic and luteal, were recorded before, during and after treatment. These included vaginal cell content, characteristics of cervical secretion, waking temperature and endometrial differentiation. There was no manifest change in the œstrogen response, but during treatment the ovulatory rise in the waking temperature was small compared with previous and subsequent records, and the progestational development of the endometrium was less than in the preceding and subsequent cycles. There were no other subjective or objective effects; for example, no changes in blood picture, urinary findings or pulse-rate. It would appear, therefore, that daily doses of roughly 20–40 mouse units did not inhibit œstrogenic secretion in the subject, but may have reduced the level of luteal secretion. The occurrence of luteinization is, of course, not incompatible with the suppression of ovulation. No risks of conception were taken by the subject during the treatment.

Our thanks are due to: Mr. W. W. Binns and Miss B. P. Jackson for pharmacognostic advice and preparation of extracts; Mr. John Gilmour and Mr. F. Hanger for collecting and cultivating *Lithospermum officinale*; Messrs. Ayerst, McKenna and Harrison, Ltd., for supplying extract of *L. ruderale*; Mr. E. C. Moran for presenting dried *L. ruderale*; Dr. Mary Barton for collecting specimens from the experimental subjects; Dr. E. N. Brand for carrying out bacteriological and other examinations; Mrs. E. N. Blacker and Miss Mary Jewell for technical assistance. The cost of these investigations was borne in part by a grant from Messrs. Kylon, Ltd. [March 25.

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REVERSAL OF THE MOLECULAR SET IN KERATIN

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THE stability of α-type proteins is due to the combined effect of hydrogen bonds and cystine cross-linkages. Thus proteins with a low cystine content, for example, myosin, are very labile under conditions favouring heat denaturation[1]; they show supercontraction in hot water, and their crystallites are transformed into the β-configuration; but this crystallographic transformation can be reversed simply by treatment in saturated urea solution[2].

Having a much higher cystine content, animal hairs are, under similar conditions, extremely stable. Even prolonged treatment in water at 90° C. (for example, for periods up to twelve days) is ineffective in producing supercontraction. Such treatments may, indeed, lead to the appearance in the X-ray photograph of the first traces of the equatorial reflexion of spacing 4·65 A.; but concurrently there is a loss of cystine sulphur[3]. In order to produce supercontraction in the presence of water alone, it is necessary to resort to high-pressure steam[4] (in which case hydrolysis of the main chain occurs) or to make use of the results of stress relaxation in stretched fibres[5].

Stability in hot water is not an exclusive property of the α-form; it is also induced in the β-form, when extended fibres (the crystallites of which are in the β-configuration) are exposed to the action of steam; this effect is generally recognized as being the cause of the 'setting' properties of keratin fibres[6].

A study of the stability of steam-set β-keratin is thus of considerable importance. In particular, a demonstration of the possibility of reversal of set β-keratin to the original α-configuration would serve two purposes: (1) from the character of the reagents capable of producing the effect it might be possible to assess the importance of the various types of molecular interaction which have been suggested as being responsible for the stability of set β-keratin; and (2) a study of the reconstituted α-keratin might throw further light on the problem of the long-range elasticity of keratin fibres.

With reference to the first point, Rudall has shown that saturated urea solutions at room temperature can reconvert set β-crystallites to the α-form, if the time of setting is restricted to a few minutes[2]. He concluded that hydrogen bonds must be responsible for the setting properties of keratin. I have obtained similar results when I treated fibres, which had been set in boiling water under tension for five minutes, in 0·15 *N* sodium hydroxide or 75 per cent lithium bromide solutions at room temperature, but only partial reconversion in 98–100 per cent formic acid. In all these reagents the degree of reversal was decreased when the time of setting was increased, and with fibres set for five hours no effect whatsoever was observed in saturated urea and only a partial effect in the other reagents. These results lend strong support to Speakman's conclusion[7], based on experiments in which the contraction of set fibres in various reagents is compared with that of normal fibres, that dimensional set is due in part to linkages other than hydrogen bonds.

Since the above reagents, chosen because of their probable effect on hydrogen bonds, are, in the main, ineffective in eliminating completely the set in the crystallites of keratin, efforts were made to find other reagents which would have the desired action. The only one which I have found to be effective is cuprammonium hydroxide. When fibres which had been set in boiling water at 50 per cent extension were immersed in solutions of this reagent, and afterwards in dilute sulphuric acid in order to remove the absorbed copper, they were left in a condition such that the X-ray photograph showed only the α-form whatever the time of the initial setting. Similar reconversion was observed in fibres set in steam at 100 per cent extension, and in fibres which had supercontracted after treatment in steam at high pressure. The degree of reconversion in such experiments depends on the time of treatment in the cuprammonium hydroxide solution, and for complete reversal to the α-form it is essential that the fibres should absorb enough copper to ensure the disappearance of the X-ray photograph[8].

Fibres in which the crystalline set had been eliminated in the way described still showed the normal reversible $\alpha \rightleftharpoons \beta$ transformation on stretching and release in water, although higher extensions than usual were necessary to produce the complete transformation. The fibres could also be set again in boiling water; the set β-crystallites were again stable except in cuprammonium hydroxide, which caused a complete reconversion to the α-configuration as before. In fact, the cycle, $\alpha \rightarrow$ set $\beta \rightarrow \alpha$, could be gone through repeatedly with the same fibres. In all these respects the fibres behaved very much like normal fibres; but that there had nevertheless been a considerable change in the properties was shown by their behaviour when exposed without constraint to the action of water at high temperatures, for such treatment produced the supercontraction and spontaneous appearance of the β-form which is, as mentioned above, characteristic of the more labile proteins. Since normal fibres are not affected in this way by the action of cuprammonium hydroxide and sulphuric acid, the linkages—or some of them—responsible for the stability of the α-form must be broken during the relaxation of tension in water at high temperatures. We may also conclude that, if the setting phenomenon is due in part to reformation of cross-linkages, their effect is not powerful enough to produce stability in cuprammonium hydroxide solution. The action of cuprammonium hydroxide solution may be either to reduce the number of such reformed linkages, a possibility which is unlikely on chemical grounds[9], or to induce refolding by a co-ordination mechanism similar to that proposed by Whewell and Woods[8] to account for the supercontraction of unstrained virgin wool fibres in cuprammonium hydroxide solutions. Even then, however, we must postulate that some of the linkages responsible for the set have actually been eliminated by the cuprammonium hydroxide, for the fibres do not revert to the β-configuration after removal of copper.

I wish to thank Mr. H. J. Woods for his advice, and Prof. J. B. Speakman and Dr. C. S. Whewell for the benefit of many discussions; I am also indebted to the International Wool Secretariat for grants in aid of these investigations. [Feb. 7.

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CARBOHYDRATIC FERMENTATION OF BACTERIAL ISOLATES FROM ZYGOPHYLLACEOUS AND LEGUMINOUS ROOT-NODULES

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So far, the previous work done on zygophyllaceous root nodules[1,2] has dealt with the following problems: (*a*) effect of soil sterilization on growth response of *Zygophyllum coccineum* and on its nodular formation; (*b*) the capacities of zygophyllaceous bacterial isolates to produce nodules in some members of Leguminosæ; (*c*) the growth response and stimulation of nodular formation in *Zygophyllum coccineum* either to its own specific bacterial isolate or to those isolated from *Tribulus alatus* and *Fagonia arabica*. In the present work, attempts have been made to elucidate the physiological identities of some zygophyllaceous and leguminous bacterial isolates in

terms of their fermentation potentialities on various carbohydratic sources. Two zygophyllaceous nodular bacterial strains, namely, those isolated from *Zygophyllum coccineum* and *Tribulus alatus*, are compared with a *Rhizobium* strain isolated from root nodules of a leguminous plant (that is, *Arachis hypogœa*).

The medium used was that suggested by Baldwin and Fred[3], with the variation of the carbon source as follows: (1) *monosaccharides:* xylose, glucose, levulose and D-galactose, and (2) *disaccharides:* sucrose, maltose and lactose. Since some sugars were found to break down during autoclaving, the medium —for each experimental carbon source—is divided into two portions: one portion was sterilized by autoclaving, and the other was cold-sterilized by Menon's technique[4]. The latter involves the transference of the medium into an ice chest and left for twenty-four hours, heated for ten minutes at 60° C., and then returned back again to the ice chest; the whole process was repeated three consecutive times.

For expressing the bacterial fermentation potentialities, the following criteria have been determined: (1) relative growth; (2) *p*H variation; (3) gas production.

Comparisons of fermentation characteristics of various monosaccharides, as induced by different bacterial isolates from zygophyllaceous and leguminous root nodules, have been made after six weeks incubation. In both xylose and glucose, incubation was carried out at 37° C., while it was at 32° C. in levulose and D-galactose. Concerning the relative growths of the three bacterial isolates, as influenced by the nature of the experimental monosaccharide, those from *Zygophyllum coccineum* and *Arachis hypogœa* show that xylose is the most favourable, followed by glucose and levulose, while D-galactose is the least favourable. Except in D-galactose, on which both *Zygophyllum* and *Arachis* bacterial isolates show a very slight growth, *Arachis rhizobium* strain shows—on the whole—a comparatively more vigorous growth than that of *Zygophyllum* on the other experimental monosaccharides. On the other hand, glucose is the most favourable for *Tribulus* bacterial isolate, followed by levulose, while both xylose and D-galactose are the least favourable. The three bacterial isolates tend to lower the *p*H value on both xylose and glucose; it does not change appreciably, however, on either levulose or D-galactose. They differ with regard to gas production; the results can be summarized as follows.

(1) The *Arachis rhizobium* strain does not produce any gas. In a similar manner, Fred, Baldwin and McCory[5] stated that the evolution of gas in liquid cultures of *Rhizobia* is not rapid enough to form gas bubbles.

(2) Except on autoclaved glucose medium, where there is gas production, *Zygophyllum* bacterial isolate behaves in a similar manner to *Rhizobia* in the non-production of gas.

(3) *Tribulus* bacterial isolate differs, however, in that gas production takes place on both autoclaved levulose and D-galactose media. The restriction of gas-production to autoclaved monosaccharide media may be due to the effect of hydrolysis during autoclaving, which enables the bacterial isolate to initiate its fermentative potentiality.

In a similar manner, comparisons have been made —on different disaccharides—after six weeks incubation at 20° C. A study of the relative growths of the three bacterial isolates shows that the most favourable one is maltose. *Tribulus* bacterial isolate continues to grow equally well, to some extent, on both lactose and glucose media. On the other hand, *Arachis* strain differs from that of *Tribulus* in exhibiting a very slight growth on different treatments of either lactose or sucrose media. Similarly, *Zygophyllum* strain shows a very slight growth on autoclaved lactose and sucrose media; its growth becomes, however, comparatively greater on the two latter disaccharides when the media are cold-sterilized by Menon's technique instead of being autoclaved. Except on lactose medium, the three bacterial isolates are found to be acid producers; they tend to lower the *p*H value. This tendency is comparatively greater with *Arachis* strain on both sucrose and maltose media. The fermentative potentiality, as expressed by gas production, is a constant and prominent feature of *Tribulus* bacterial isolate on the differently treated experimental disaccharide media. On the other hand, both *Zygophyllum* and *Arachis* strains agree in their feeble fermentative potentialities; gas production can only be detected either when *Zygophyllum* bacterial strain grows on cold-sterilized lactose or when that of *Arachis* grows on autoclaved maltose.

Thus, according to fermentation characteristics on different monosaccharides and disaccharides, the three bacterial isolates can roughly fall into two categories: one category includes the two bacterial isolates from root nodules of *Zygophyllum coccineum* and *Arachis hypogœa*, and the other contains only *Tribulus* bacterial strain which stands rather physiologically distinct. The similarity of *Zygophyllum* and *Arachis* bacterial isolates manifests itself in the following behaviours: (1) the most favourable monosaccharide for growth is xylose, followed by glucose and levulose, while the least favourable is D-galactose; (2) the feeble or non-production of gas on most monosaccharide and disaccharide media; (3) the most favourable disaccharide for growth is maltose, while there is a very slight growth on autoclaved lactose and sucrose media. *Tribulus* bacterial isolate differs, however, with regard to its relative growth on different monosaccharide and disaccharide media and with regard to its fermentative potentialities. It produces gas on all differently treated disaccharide media, as well as on two autoclaved monosaccharide media (namely, levulose and D-galactose).

This work indicates that the two zygophyllaceous bacterial strains, namely, those isolated from root nodules of *Zygophyllum coccineum* and *Tribulus alatus*, are physiologically distinct in respect to their relative growths and to their fermentation potentialities. *Zygophyllum coccineum* bacterial isolate behaves even more similarly to leguminous *Arachis rhizobium* strain than to that of its zygophyllaceous colleague isolated from *Tribulus alatus*. Further work on the fermentation potentialities of the three bacterial nodular isolates, on different polysaccharides and nitrogen sources, are still in progress.

I wish to express my gratitude to Mr. Z. Mahmoud for his continual assistance. [June 12.

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LETTERS TO THE EDITORS

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Stereochemistry of the Tropane Alkaloids

The respective C_3-configurations of the epimeric N-acyl-nortropins have been recently established from the different behaviour of the epimers[1] in acyl migration, N → O. Naturally occurring psi-tropine derivatives seem on this basis to contain a hydroxyl group *syn*-placed to the ring-nitrogen. Atropine, hyoscyamine, convolamine, being hydrolysable to tropine or nortropine, appear, therefore, to represent *anti*-3-tropanol structures.

These investigations have now been extended to ecgonine (I *b*) and psi-ecgonine (II *b*), and to two cocaine-epimers.

Ecgonine and psi-ecgonine are C_3-epimers[2]. In alkaline medium ecgonine is converted[3] into psi-ecgonine, in analogy to the tropine (*anti*-tropanol) → psi-(*syn*)-tropine conversion, which indicates identical C_3-configuration for tropine and ecgonine, and the respective epimeric configurations for the corresponding ψ-derivatives.

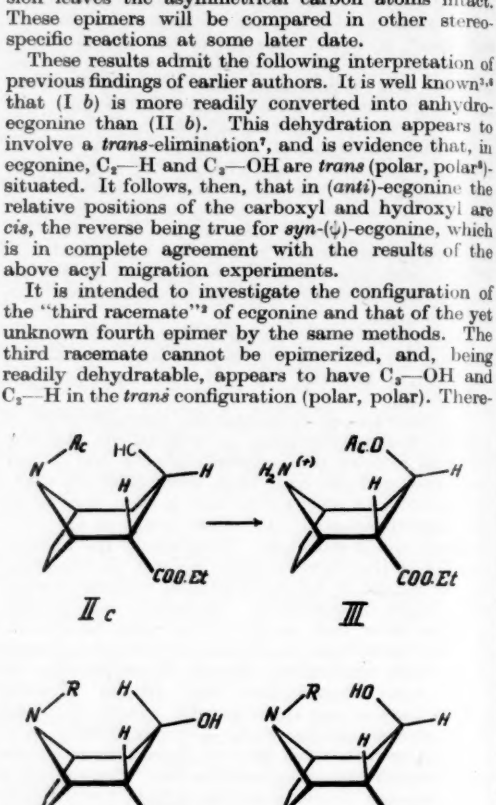
This inference has now been confirmed experimentally. Hydrogen chloride in dioxane converts N-acetyl-nor-ψ-ecgonine ethyl-ester (m.p. 112°) (II *c*) to O-acetyl-nor-ψ-ecgonine ethyl-ester hydrochloride (m.p. 226°; $[\alpha]_D = +23{\cdot}6°$) (III), while under strictly identical conditions no amino ester was obtained from the epimeric nor-ecgonine derivative (II *a*). In ψ-nor-ecgonine and its derivatives, the C_3-hydroxyl seems, therefore, to be *syn*-placed to the nitrogen, the opposite following for nor-ecgonine and cocaine.

These results did not permit any statement to be made on the position of the C_2-carboxylic group of the *syn* and *anti* ecgonine epimers with respect to the C_3-hydroxyl. No generally applicable methods being available for the determination of the configuration of beta-hydroxy-carboxylic acids[4], an attempt was made to overcome this difficulty by converting the two ecgonine C_3-epimers to the corresponding 2-amino-tropanol-3-epimers and subsequent comparison of the respective N-benzoyl derivatives (IV and V). In this conversion the migrating group would—just as in the Curtius reaction—be assumed to retain its configuration[5], which then makes it possible to determine the steric position of the amino-group in respect to the carboxylic group and, by inference, the configuration of the carboxyl in the original ecgonine epimers.

2-Benzamido-3-*anti*-tropanol (m.p. 163°, $[\alpha]_D = -6°$; IV), prepared from *anti*-ecgonine, was converted by absolute ethanolic hydrogen chloride quantitatively into 2-amino-3-*anti*-benzoyloxy-tropane *bis*-hydrochloride (m.p. 214–216°; $[\alpha]_D = -22°$; VI). Under identical conditions, 2-benzamido-*syn*-3-tropanol (V; m.p. 205°) affords only the monohydrochloride of (V), that is, in the latter case no acyl migration N → O is taking place. Thus the amino and hydroxyl groups are shown to be *cis* in the 2-amino-*anti*-tropanol, and *trans* in the *syn*-tropanol epimer. Obviously, in ecgonine and in cocaine the carboxylic and C_3-hydroxyl groups occupy the same corresponding positions. Hence, cocaine is (−) 2-*cis*-carbomethoxy-3-*anti*-benzoyloxy-tropane. As another approach to the problem, the two ecgoninol C_3-epimers were prepared by reduction of the methyl esters of (I) and (II) with lithium aluminium hydride, which conversion leaves the asymmetrical carbon atoms intact. These epimers will be compared in other stereospecific reactions at some later date.

These results admit the following interpretation of previous findings of earlier authors. It is well known[3,6] that (I *b*) is more readily converted into anhydro-ecgonine than (II *b*). This dehydration appears to involve a *trans*-elimination[7], and is evidence that, in ecgonine, C_2—H and C_3—OH are *trans* (polar, polar[8])-situated. It follows, then, that in (*anti*)-ecgonine the relative positions of the carboxyl and hydroxyl are *cis*, the reverse being true for *syn*-(ψ)-ecgonine, which is in complete agreement with the results of the above acyl migration experiments.

It is intended to investigate the configuration of the "third racemate"[2] of ecgonine and that of the yet unknown fourth epimer by the same methods. The third racemate cannot be epimerized, and, being readily dehydratable, appears to have C_3—OH and C_2—H in the *trans* configuration (polar, polar). There-



fore, the C_3—OH would be predicted to be *sym* placed in respect of the nitrogen. For the fourth racemate, therefore, the structure of a 2-*trans*-carboxy-3-*anti*-tropanol seems to be valid.

Our experiments also point to the fact that scopolamine and scopine (VII *a* and *b*) can only be derivatives of tropine (*anti*-3-tropanol), as they are readily converted[9,10] into the tetrahydrofurane derivative scopoline. The rupture of the epoxide ring of scopolamine can only be attributed to the rearward nucleophilic attack of the C_3-oxygen. Accordingly, the *trans* position of the epoxide ring of scopolamine, as well as that of the C_6-hydroxyl group of scopoline in relation to the C_3-oxygen, appears to be likewise proved. It is intended to establish these predictions by experimental investigation of the existing configurative correlations between scopolamine, valeroidine and tropine.

Experimental details will be submitted to the *Journal of the Chemical Society*.

Note (*March* 28).—Ecgoninol can be converted in the presence of benzenesulphonic acid to the cyclic benzylidene acetal, whereas ψ-ecgoninol remains unchanged under the same conditions.

Ecgonine (I) and ψ-ecgonine (II) fail to form chloralids, (I) undergoing dehydration to anhydroecgonine and (II) remaining unchanged.

These findings support the configuration ascribed above to the ecgonine epimers.

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Use of *n*-Butanol–Formic Acid–Water Mixture in the Paper Chromatography of Amino-Acids and Sugars

During the course of a systematic investigation of the amino-acids of the sugar cane, it became desirable to record simultaneously the amino-acid distribution in material from several sources. Two-dimensional chromatograms developed by Consden, Gordon and Martin[1], although effecting excellent resolution of the constituents of a mixture, suffer from the disadvantage that only one sample can be mapped at a time. Moreover, the application of controls necessitates the preparation of separate maps. On the other hand, the single-dimensional 'strip chromatogram' offers a much more rapid method of analysing mixtures of amino-acids; but the use of phenol-aqueous ammonia as solvent was found to give rather poor separation of individual amino-acids. Under tropical conditions, darkening of the solvent was an added difficulty.

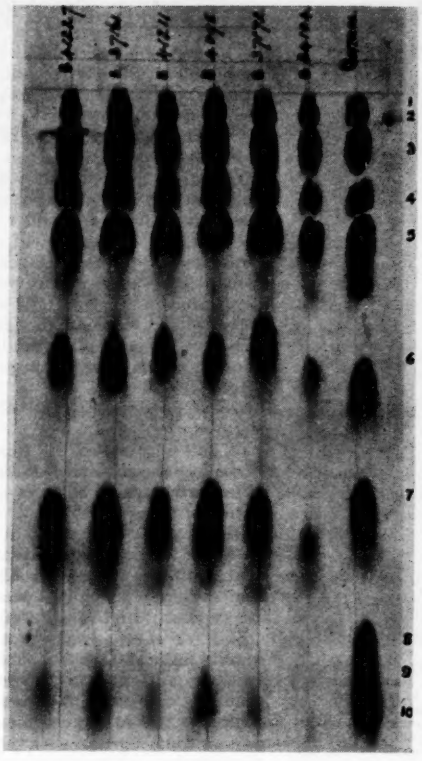

Fig. 1. Chromatogram of amino-acids from six varieties of cane juice. Amino-acids in the control mixture are: 1, lysine; 2, asparagine; 3, aspartic acid; 4, glutamic acid; 5, alanine; 6, α-aminobutyric acid; 7, valine; 8, *iso*leucine; 9, leucine; 10, *nor*leucine

The use of a solvent consisting of *n*-butanol–formic acid–water has been found to give greatly improved separation of the amino-acids, and to be free from the numerous objections to the use of phenolic solvents. The solvent was prepared by refluxing for an hour a mixture of formic acid (90 per cent, 50 c.c.), *n*-butanol (600 c.c.) and water (50 c.c.). A further 300 c.c. of water was then added and the mixture shaken from time to time during cooling. After being kept for twenty-four hours, the upper solvent layer was separated and was then ready for use.

Fig. 1 is a photograph of a typical chromatogram obtained for the amino-acids of the juice of six varieties of mature sugar cane. These cane varieties, all derived from the Cane Breeding Station in Barbados, were grown in Trinidad concurrently and were harvested at the same time. The amino-acids were obtained from the fresh juice by adsorption on columns of 'Amberlite IR 120', followed by washing with water and elution with dilute ammonia. After concentration *in vacuo*, the extracts were chromatographed on Whatman No. 1 filter paper in the usual manner for forty hours in the above solvent. The chromatograms were developed by spraying with ninhydrin (0·4 per cent) and cobalt chloride (0·2 per cent) in *iso*propyl alcohol, and heating at 110° C. for ten minutes. The amino-acids showed up as

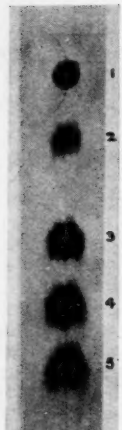

Fig. 2. Chromatogram of a sugar mixture in formic acid-*n*-butanol-water solvent. The sugars shown are: 1, raffinose; 2, sucrose; 3, glucose; 4, fructose; 5, xylose; 6, rhamnose

salmon-coloured spots rapidly turning bright magenta red.

The six varieties of sugar cane examined all show a very similar amino-acid pattern, as can be seen from the photograph, which also indicates the identity of the individual spots shown on the chromatogram. An interesting point is that, in the solvent used, asparagine has a smaller R_F value than aspartic acid (the sequence of amino-acids in the control mixture was previously determined by running them separately), whereas in phenol the reverse is true. Similarly, lysine, which has a large R_F value in phenol, has a very small R_F value in the solvent here described.

A full account of the qualitative and quantitative examination of the amino-acids of sugar cane will be published elsewhere.

The solvent described above can also be used satisfactorily for the chromatographic separation of sugars. Fig. 2 is a photograph of a chromatogram obtained in a 40-hr. run from a mixture of glucose, fructose, sucrose, xylose, rhamnose and raffinose, after development of the chromatogram with aniline phosphate in butanol, a reagent which, as found by Bryson and Mitchell[2], showed up all the sugars satisfactorily.

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May 16.

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Plasma Thromboplastin

When whole normal blood clots in a glass tube, the generation of thrombin can be observed by removing 0·1-ml. amounts at intervals and adding these to fibrinogen. The clotting times of the fibrinogen samples will record the amount of thrombin present. When this is done, it is found that there is a phase lasting 3–4 min. in which no thrombin can be detected. Thereafter an extremely rapid formation of thrombin occurs, and all the prothrombin is converted to thrombin in 2 or 3 min. This separation of thrombin formation into two phases suggests that there is a powerful intrinsic thromboplastic activity of blood, but that 3–4 min. are required for its formation.

The plasma of a patient deficient in prothrombin but apparently lacking in no other factors was useful for the demonstration of plasma thromboplastin activity. A 1/5 dilution of the patient's plasma was mixed with washed platelets from normal plasma and calcium chloride. At intervals samples were removed from this incubation mixture and added to normal plasma made platelet-deficient by centrifuging, and the mixtures were immediately recalcified. The clotting times of the normal plasma mixtures are shown in Table 1. In this experiment the clotting of the substrate plasma samples certainly cannot be attributed to thrombin transferred from the incubation mixture because very little thrombin was formed. The potency of this thromboplastin requires little emphasis. A 1/5 dilution of plasma mixed with platelets formed a thromboplastin comparable in strength to undiluted brain emulsions.

Table 1. Formation of Thromboplastin in Prothrombin-deficient Plasma

0·3 ml. of 1/5 plasma was mixed with 0·3 ml. platelet suspension (313,000 per c.mm.) and 0·3 ml. of *M*/40 $CaCl_2$. At intervals 0·1 ml. of this incubation mixture was added to 0·1 ml. of normal plasma and the mixture immediately recalcified with 0·1 ml. of *M*/40 $CaCl_2$. The clotting times are recorded in seconds. The fibrinogen clotting times give an indication of the amounts of thrombin transferred from the incubation mixture.

Incubation mixture	Substrate	Time intervals in minutes for withdrawal of samples from the incubation mixture								
		½	1	2	3	4	6	8	16	32
Equal parts of: (1) Prothrombin-deficient plasma 1/5	Recalcified normal plasma	37	24	18	16	16	15	15	17	21
(2) Platelets (3) *M*/40 $CaCl_2$	Fibrinogen	660	163	300	460	570	960	1,800+		

The factors required for the formation of thromboplastin are platelets, the 'antihæmophilic globulin' and factor VII[1]. Factor VII is probably identical with serum prothrombin conversion accelerator[2], convertin[3], and co-thromboplastin[4]. The formation of this thromboplastin in the factors isolated from normal plasma and serum is shown in Table 2.

Table 2. Formation of Thromboplastin from Factors Isolated from Normal Plasma and Serum

Antihæmophilic globulin'. The fraction precipitated by 33 per cent saturation with $(NH_4)_2SO_4$ from normal plasma previously treated with $Al(OH)_3$ to remove prothrombin.
Factor VII. The fraction of serum prepared by $Al(OH)_3$ adsorption and subsequent elution with phosphate buffer at *p*H 8.
Platelets: 700,000 c.mm. prepared from normal plasma.
0·2 ml. amounts of antihæmophilic globulin, factor VII, platelets and *M*/40 $CaCl_2$ were mixed, and at intervals 0·1 ml. of the incubation mixture was added to 0·1 ml. of normal plasma and the mixture immediately recalcified with 0·1 ml. of *M*/40 $CaCl_2$.
The clotting times were recorded in seconds.

Incubation mixture	Substrate	Time intervals in minutes for the withdrawal of samples from the incubation mixture					
		1	2	4	8	16	32
Equal parts of 'antihæmophilic globulin', factor VII, platelets, *M*/40 $CaCl_2$	Recalcified normal plasma	53	51	25	13	13	14

It appears that platelets are the main quantitative precursor of thromboplastin, and that the antihæmophilic globulin and factor VII are required in relatively small amounts. This work will be reported in detail elsewhere.

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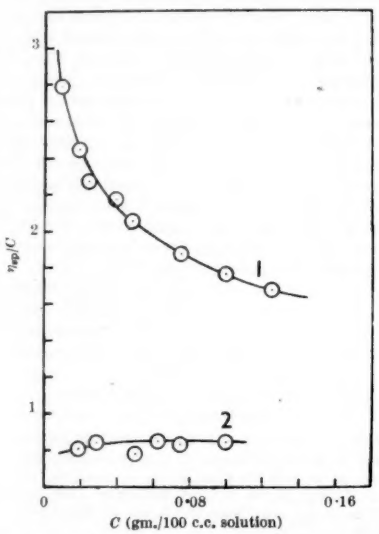
Viscosity of Sodium Salt of Polyuronide Hemicellulose from Jute

It has been observed by Fuoss and Strauss[1] that the viscosity behaviour of a polymer such as polyvinylbutyl pyridonium bromide, containing ionizable groups, in water is not the same as that of a neutral polymer. The reduced viscosity (η_{sp}/C) of the former (a polyelectrolyte), unlike that of a neutral polymer, increases on dilution. A similar behaviour has been noted by Pals and Hermans[2] in the case of sodium pectinate. Basu[3] has studied the viscosity of sodium thymonucleate, which also behaves as a polyelectrolyte. The present communication describes the viscosity measurements of the sodium salt of methyluronic acid – xylan complex[4] (a jute hemicellulose fraction). As this uronic acid is believed to occur in a chain molecule, it was thought that the sodium salt of the complex in aqueous solution might also behave as a polyelectrolyte. This does not appear to have been studied hitherto.

The results of viscosity determinations are shown graphically; curve 1 shows that the reduced viscosity actually increases on dilution. In the presence of 0·1 *N* sodium chloride solution, the sodium salt behaves as a neutral polymer. These facts may be readily explained by the conception of polyelectrolytes put forward by Fuoss and Strauss[1]. Viscosities were measured in an Ostwald viscometer with an efflux time for water of about 165 sec. at 32° C.



Reduced viscosity of (1) sodium salt of methyluronic acid – xylan complex; (2) same in presence of sodium chloride

Defatted jute was delignified with 'Textone'[5]; the air-dry holocellulose thus obtained was treated with 9·3 per cent caustic soda solution (w/w) at room temperature for two hours and filtered through a sintered-glass filter. The filtrate was acidified with glacial acetic acid, and an equal volume of absolute ethyl alcohol was then added. The precipitate was filtered off and washed free from acetate with aqueous ethyl alcohol (1 : 1). The sodium salt of hemicellulose (acetic acid is too weak to decompose it) thus obtained was purified by dissolving in 4 per cent caustic soda solution at room temperature, filtering and washing the precipitate first with aqueous ethyl alcohol (50 per cent) and then with absolute alcohol. This was dried in a vacuum desiccator over concentrated sulphuric acid.

My thanks are due to Dr. P. B. Sarkar, director of the Technological Research Laboratories, Indian Central Jute Committee, for his interest in this work.

P. K. Saha

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Jan. 28.

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Biological Activity of some Enteramine-related Substances

The action of enteramine on various biological test objects has been established in previous investigations[1].

The present communication represents a preliminary contribution to the comparative study of the actions developed, on some of the most important and significant biological reactives of enteramine, by a number of enteramine-related indole derivatives.

The results obtained with indol- and hydroxyindolalkylamines on the diuresis of hydrated rats (antidiuretic action), on the blood pressure of the spinal cat (hypertensive action), as well as on the isolated œstrus–uterus of the rat, and the *in situ* urinary bladder of the dog (stimulant action), are summarized in the accompanying table.

The activity of enteramine is arbitrarily taken as 100; the activity of the other substances is expressed in percentage.

	Hydrated rats' diuresis	Rat œstrus–uterus	Dog urinary bladder	Spinal cat blood pressure
Enteramine	100	100	100	100
Bufotenine	6–7	10	5–10	50
Bufotenidine	<0·3	0	?	400–600
Bufothionine	0	0	0	0
Dehydrobufotenine	0	0	0	0
Tryptamine	0·3–0·5	1–1·5	1·5	12–16
1-Methyltryptamine	0·1–0·2	1–3	1–1·5	10–12
N-Methyltryptamine	<0·3	<0·5	<0·5	10
N,N-Dimethyltryptamine	<0·3	<0·5	<0·5	6–8
5-Methoxytryptamine	25–40 diuretic action	25–30 inhibition	30–35 inhibition	30–50 2,000–3,000
Adrenaline				

The following compounds have proved wholly inactive on all the above biological reactives: indole, skatole, 5-methoxyindole, β-(indole-3)-acetic acid, β-(indole-3)-propionic acid, γ-(indole-3)-*n*-butyric acid, tryptophane, tryptophanol, hypophorine.

From the data in the table and from the study of numerous records, the following conclusions may be drawn.

(*a*) Among the indolalkylamines hitherto tested, enteramine possesses the most powerful action on the diuresis and the uterus of the rat, and on the urinary bladder of the dog. Moreover, the biological reactives are in no way damaged by the substance, as shown by the easily repeatable pharmacological response, and, when working with isolated organs,

by the prompt reversibility of this response, however intense it may be, after washing out.

This by no means occurs with bufotenine or with the methyltryptamines, which, on the contrary, may greatly damage the smooth muscle.

(*b*) 5-Methoxytryptamine is the product which most closely approaches to enteramine, both qualitatively and quantitatively; bufotenine (= N,N-dimethylenteramine) does it to a much lesser degree.

It seems, therefore, that for the appearance of the specific antidiuretic and uterus-stimulating actions the peculiar structure of the lateral chain of enteramine (chain with two carbon atoms, with a primary amino-group attached to the terminal carbon atom) is as important as the presence of a free phenolic hydroxy group in position 5.

(*c*) A satisfactory agreement exists between the antidiuretic action of the different substances and their uterus- and bladder-stimulating action. No relationship exists, on the contrary, between the antidiuretic action and the hypertensive action in the spinal cat.

I wish to thank Prof. R. H. Manske for the methyltryptamines.

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A Bacterial Growth-Factor Synthesized by a Soil Bacterium

Earlier studies in this laboratory[1] have indicated the presence in soil of bacteria dependent upon growth-factors provided by soil extract but not by yeast extract nor by combinations of amino-acids and vitamins (not including B_{12}). More recently it was shown[2,3] that for many of the indigenous soil bacteria dependent upon essential growth-factors supplied by soil extract, the nutrilite effect of the latter could be replaced by vitamin B_{12}. Other micro-organisms, however, remained dependent upon unidentified growth-promoting substances in soil.

In a study of the growth requirements of certain bacterial strains for the nutrition of which vitamin B_{12} was unable to replace soil extract, it was found that a number of bacteria isolated from soil and having simple nutritional needs were able to synthesize a factor nutritionally equivalent to soil extract. Using a selected test organism requiring the growth-factor (No. 88) and one capable of synthesizing it (No. *B*89), both pleomorphic bacteria of the 'soil diphtheroid' type and apparently undescribed species, more detailed study was made. With a basal medium of inorganic salts, sugar and yeast extract ('Difco'), the test organism gave no response to the addition of any of the following: thiamine, riboflavin, niacin, pyridoxin, pyridoxal, pyridoxamine, pantothenic acid, biotin, folic acid, vitamin B_{12}, *p*-aminobenzoic acid, inositol, choline, combinations of B vitamins, cytosine, thymine, uracil, adenine, guanine, xanthine, cystine, β-alanine, ribonucleic acid, deoxyribonucleic acid, oleic acid, tomato juice filtrate, casamino-acids, enzymatic casein digest and soil extract ash. On the other hand, growth resulted from additions of small amounts of the culture filtrate of organism No. *B*89, grown in a simple nutrient medium containing only inorganic salts and sugar (see accompanying table). Partially purified material from the metabolic liquid

Growth Response of Organism No. 88 (Washed Cells)

Addenda to basal medium*	Optical density (aver. of 4 tests)
None	0·005
Soil extract	0·132
B vitamins, purines and pyrimidines	0·005
0·00001 ml. culture filtrate *B*89/ml.	0·007
0·00002 " " " "	0·014
0·00003 " " " "	0·044
0·00004 " " " "	0·083
0·00005 " " " "	0·105
0·00007 " " " "	0·149
0·00010 " " " "	0·180
0·001 " " " "	0·196
Liver extract (0·37 mμ gm. B_{12}/ml.)	0·007
" " (3·75 " ")	0·075
" " (37·5 " ")	0·228
" " (75·0 " ")	0·194
Crystalline vitamin B_{12}, 0·37 mμ gm./ml.	0·003
" " 3·75 "	0·003
" " 37·5 "	0·004
" " 75·0 "	0·003

* Salts, glucose and yeast extract.

gave observable growth response at approximately 0·1 p.p.m. concentration.

It was further found that a growth-factor effect equivalent to that given by filtrate *B*89 was obtained on addition of injectable "15 unit" liver extract. The effect was not attributable to vitamin B_{12} as indicated in the table, showing results with different amounts of liver extract and equivalent concentrations of crystalline vitamin B_{12}. Growth stimulation of *Lactobacillus leichmannii* by a factor in liver extract which promotes growth in excess of that attributable to vitamin B_{12} has been reported[4], while concentrates from liver have been found[5] to contain a factor required by *Leuconostoc citrovorum* which appears to be identical with 'folinic acid'[6]. Since these factors were reported to be present in yeast or yeast extract, there is reason for assuming that the factor produced by organism *B*89 is a different substance. This latter is believed to represent a nutrilite required for the growth of a group of indigenous soil bacteria and to contribute to the growth-promoting properties of soil extract. It is considered a matter of interest that it is nutritionally equivalent (for the test bacterium) to a factor in liver extract and that it is a product of microbial synthesis.

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Inhibitors of Hyaluronidase

An unsolved problem in the study of rheumatic diseases is whether or not hyaluronidase plays any part in the typical changes in the connective tissue, particularly of the interfibrillar cement substance, which is believed to contain hyaluronic acid. Guerra[1], for example, claimed that sodium salicylate significantly inhibits the spreading power of hyaluronidase injected into the skin, and therefore ascribed the value of salicylate in rheumatic fever to an action of the drug on the hyaluronidase–hyaluronic

acid system of the body. Meyer[2] and Dorfman *et al.*[3] confirmed these observations, but gave no experimental data. Later, Meyer and Ragan[4] argued that the effect claimed by Guerra was due not to the salicylate but to gentisate, a supposed metabolic product of salicylate. Further research has since shown that therapeutic concentrations of salicylate[5,6] or gentisate[7] are too weak to inhibit hyaluronidase *in vitro*. Moreover, Swyer[6], Dalgaard-Mikkelsen[8] and Jones[9] failed to find any demonstrable effect of salicylate on the spreading activity of hyaluronidase injected into the rabbit's skin. The evidence is thus contradictory and too weak to ascribe the value of salicylate in rheumatic fever to an inhibition of hyaluronidase.

In an endeavour to clear up this problem, an investigation was started at this laboratory in 1948. The purposes of the investigation were to find potent, non-toxic inhibitors of hyaluronidase, and to ascertain: (*a*) whether any such inhibitors are capable of influencing the course of pathological changes in the ground substance of mesenchymal tissue; and (*b*) whether they are of value in the prophylactic or therapeutic treatment of diseases secondary to infections with bacteria producing hyaluronidase, hyaluronidase being known to increase the permeability of the tissue and thereby presumably to favour the invasion of the tissues by other micro-organisms.

Numerous organic compounds were tested viscosimetrically for hyaluronidase-inhibiting properties. Highly purified testis hyaluronidase was mixed with the substance to be tested. Thirty minutes later the mixture was added to a 0·2 per cent solution of hyaluronic acid from umbilical cord, which was adjusted to a *p*H of 7 by means of phosphate. Readings were taken at 37° C. after different intervals. The investigation will be reported in detail elsewhere[10]. Certain polycondensation products built up of substituted diphenylmethane units proved powerful inhibitors of testis hyaluronidase. These compounds were obtained by allowing dihydroxy- or trihydroxy-benzoic acids to react with formaldehyde under conditions favouring the formation of condensation products of fairly high molecular weight. Substitution in the methylene groups of these compounds by monohydroxy- or polyhydroxy-carboxyphenyl radicals produced still stronger inhibitors. These compounds were synthesized by oxidizing polycondensed diphenylmethane derivatives with nitrous acid in the presence of suitable phenol derivatives. The inhibitory activity *in vitro* of some polycondensed diphenyl- and triphenyl-methane derivatives and the acute oral toxicity of the compounds in mice are summarized in the accompanying table, which, for purposes of comparison, includes also corresponding values for salicylic acid and gentisic acid.

Compound		Inhibitory action on hyaluronidase (relative units : resorcinol = 1)	Acute oral toxicity (LD_{50} in mgm./100 gm.)
Polycondensed methylenedigentisic acid	7*P*	2,000	1,000
Polycondensed methylenedi-γ-resorcylic acid	24	1,850	460
Polycondensed hexahydroxytricarboxytriphenylmethane ('trigentisic acid')	21*P*	2,485	> 1,500
Polycondensed heptahydroxytricarboxytriphenylmethane ('di-β-resorcylic-gallic acid')	16*P*	1 300	540
Polycondensed heptahydroxytricarboxytriphenylmethane ('digentisic-gallic acid')	30	2,275	1,250
Salicylic acid		0·2	100
Gentisic acid		0·8	300

Of the diphenylmethane derivatives, it was a high-molecular weight condensation product of methylene-digentisic acid that showed the highest *in vitro* activity. The inhibitory activity of the triphenylmethane derivatives synthesized by the reaction of polycondensed digentisic acid with gentisic acid or gallic acid was even stronger. The toxicity of the diphenylmethane and triphenylmethane derivatives tested is low (see accompanying table). The strong inhibitory action of these compounds was confirmed by experiments *in vivo*.

Reports[11,12] of these *in vivo* experiments and of clinical trials with the new inhibitors will be published in due course.

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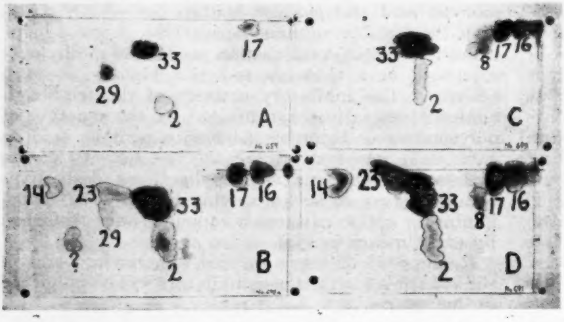
Free Amino-Acids in the Leaves, Roots and Root Nodules of the Alder (*Alnus*)

An intensive fixation of atmospheric nitrogen takes place not only in the root nodules of leguminous plants but also in those of the alder[1]. For example, in a quartz sand culture of *Alnus glutinosa* with no combined nitrogen the growth was 261 cm. in length and the increase of nitrogen in the plant about 6·5 gm. in the second year (Virtanen and Saubert-v. Hausen). In order to gain information on the mechanism of the atmospheric nitrogen fixation and the nitrogen metabolism in general we have examined the seasonal occurrence of free amino-acids in the different parts of *A. glutinosa* and *A. incana*.

The free amino-acids were extracted by aqueous ethanol (70 per cent by weight) and the extracts were examined by two-dimensional paper chromatography (Fig. 1). Quantitative determinations were made by visual comparisons with a known series of dilutions. This method gives an accuracy of about 20–30 per cent. The method was controlled in respect to citrulline photometrically by diacetyl monoxime reaction[2].

The free amino-acid found most abundantly in the roots and nodules of the alder is L(+)-citrulline. In this respect alder differs distinctly from the leguminous plants, for example, *Pisum* and soya bean, in the roots and nodules of which asparagine and glutamine are found in abundance, but no citrulline[3,4]. Asparagine and glutamine are not found in the roots nor in the nodules of alder. The citrulline content of the nodules of both *Alnus* spp. increases greatly in the

← II: Phenol + 0·5% ammonia, 36 hr.



↓ I: n-Butanol, 6 days

Paper chromatograms of alcoholic (70 per cent by wt.) extracts from alder roots and nodules. Paper: Whatman No. 1, development by ninhydrin. *A*, nodules of *A. incana*; *B*, nodules of *A. glutinosa*; *C*, unnodulated roots of *A. glutinosa*; *D*, nodulated roots of *A. glutinosa*. 2 = alanine, 8 = serine, 14 = arginine, 16 = aspartic acid, 17 = glutamic acid, 23 = ornithine, 29 = γ-amino-butyric acid, 33 = citrulline

autumn, rising from about 0·2–0·3 per cent in the summer time to about 1–2 per cent of the dry weight of the tissue.

To confirm the identity of citrulline, it was isolated from the nodules of *A. incana* as the difficultly soluble copper salt, m.p. 266–268° C., which was in every respect identical with the authentic Cu-L(+)-citrullinate. The yield was 0·6 per cent of the dry weight. The nodules were harvested in October.

The nodules of *A. incana* (samples taken from Nature in August and October) contain, in addition to citrulline, appreciable quantities of γ-amino-butyric acid (*c.* 0·2 per cent of dry weight) with smaller amounts of alanine and glutamic acid but no other free amino-acids (Fig. 1,*A*).

The nodules of *A. glutinosa* (from laboratory cultures in January and May) differ from those of *A. incana* mainly by containing only traces of γ-amino-butyric acid (Fig. 1,*B*). In addition, they contain some aspartic acid and small amounts of arginine and ornithine. The roots of *A. glutinosa* (from laboratory culture in January) differ from the nodules taken from the same plant by containing somewhat less citrulline but much more arginine and ornithine (*c.* 0·1–0·2 per cent of dry weight) (Fig. 1,*D*). Those parts of the roots which are nearest to the nodules possess considerably higher concentrations of free amino-acids than do the more remote parts, but there is no qualitative difference. The leaves of *A. glutinosa* differed from the roots and nodules of the same plant mainly by containing less citrulline.

To ascertain whether the occurrence of citrulline in the nodules of the alder is possibly due to nitrogen-fixation taking place in the nodules or to nitrogen-metabolism, the free amino-acids of unnodulated alder roots were also examined. These alders were grown in sand and water cultures with combined nitrogen: nitrate, ammonium, aspartic acid–nitrogen. It was found that such roots, too, contain citrulline (Fig. 1,*C*), although considerably less than the nodulated roots (*c.* 0·1 per cent in winter). The presence of citrulline in the roots of alder is thus no consequence of the fixation of molecular nitrogen.

Other two-dimensional paper chromatograms were sprayed by *p*-dimethylamino-benzaldehyde reagent[5], which reacts with urea and ureides on paper, giving yellow spots. Intense citrulline spots were obtained from all the root and nodule extracts; but a detectable amount of urea was present only in the extract from the unnodulated roots (less than 0·01 per cent of dry weight).

So far as we know, citrulline has not been found in the higher plants except in watermelon (*Citrullus vulgaris*), from which it was originally isolated by Wada in 1930 [6]. It is probably produced in alder roots by the Krebs–Hensleit cycle[7] from ornithine as in the animal organism, although there is no direct proof of this so far. It is noteworthy that in winter the concentration of free arginine and ornithine is high in the roots near to the nodules but not in the nodules. Borsook and Dubnoff[8] have shown that citrulline reacts with glutamic or aspartic acid while it is converted to arginine.

The great accumulation of citrulline in the nodules in the autumn suggests that citrulline in the alder may have the role of a nitrogen store similar to that envisaged for glutamine and asparagine in the leguminous plants.

A detailed description of this work will be published later.

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A New Method for Isolating Members of the Acrasieæ from Soil Samples

Methods for isolating members of the Acrasieæ, which are slime moulds producing pseudoplasmodia and inhabiting soil, have been reported by various workers[1–3]. The usual procedure is to inoculate directly on special media soil crumbs or soil/water suspensions from samples being tested. The bacteria from the soil develop colonies which in turn become the food source for the feeding myxamœbæ of the slime moulds.

The objection to these methods is that the fruiting phase of the Acrasieæ is often sparse and also overgrown by various mould members of the fungi. This latter objection is true in part even on the nutrient 'lean' soil agar[4], which does delimit the growth of the unwanted forms. For these reasons a means was sought of isolating members of the Acrasieæ which would make it less difficult and cumbersome to subculture the organism into 'pure-mixed' cultures[5] on *Escherichia coli*.

The new technique described here is simpler to operate and is more efficient. It tests larger quantities of soil and still eliminates the contaminating growth of other fungi almost completely. It also gives a view of the organisms under investigation more nearly as they would appear *in vivo* in soil. The new approach consists simply in first smear-inoculating nutrient agar plates with *Escherichia coli*, ensuring a heavy growth. Then with a sterile inoculating wire

the growth is skimmed off the agar surface after 24-hr. incubation and suspended in sterile water.

The soil samples to be tested were previously prepared and placed in 25-c.c. specimen bottles. These were sprinkled liberally with the bacteria in water suspension, enough to moisten the soil, not inundating it. I find the 25-c.c. specimen bottles used by many of the biological supply houses are more than adequate for this purpose. The soil samples were loosely pulverized before being placed in the sterile 25-c.c. jar to the level of one-half full. The loose-fitting metal cover completes the incubating chamber, which is allowed to stand at room temperatures varying within limits of 20° to 23° C. After two days, pseudoplasmodia are visible, and after three days numerous fruiting bodies will appear if the organisms were originally present in the soil samples.

It is interesting to note that perhaps the appearance of the fruiting bodies on these cultures is more like what it must appear to be in Nature, inasmuch as they are on their natural substrate.

Escherichia coli was used as the bacterial food supply, since past reports, and also my own experience, show that it is most suitable. Also this bacterium makes an excellent food source for the Acrasieæ in 'pure-mixed' culture. Sub-culturing from the isolation vials is a simple step of transferring a sorus to agar containing a 24-hr. old streak of *Escherichia coli*.

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Nerve Impulses Originating from the Compound Eye of the Locust

Electrical changes in response to illumination of the insect eye have been studied previously[1]. These have been related mainly to relatively slow potential variations, of the nature of retinal potentials, recorded from the eye itself. In addition, impulses in the circum-œsophageal commissures of *Locusta migratoria* correlated with changes of illumination have been reported[2].

We have found that similar or identical impulses, which are of large amplitude and rapid conduction, may be detected in the ventral nerve cord of the insect, as far caudally as the last thoracic ganglion, but not farther. The impulse discharges, which were always in the form of short bursts, were found to be related to two types of stimulus: (*a*) switching the light on and off (constant illumination gave no discharge); (*b*) movement of an illuminated object in the field of vision. The 'on' and 'off' discharges seem to correspond with the 'on' and 'off' responses which occur in vertebrate eyes, with the distinction that in our experiments these responses were detected in the central nervous system of the insect, at some distance from the eyes. The responses to movement, (*b*), may be simply related to (*a*), in that a shift of illumination from one ommatidium to another may be expected to give rise to an 'off' response, immediately followed by, or merging into, the succeeding 'on'. Hence single rapid movements of small extent are accompanied by single bursts of impulses. On this supposition, therefore, the smallest detectable shift of a light/dark boundary in the visual field would be referable to an angular movement corresponding to the angle subtended between the axes of two adjacent ommatidia, or a lesser angle.

Our experimental results have so far supported this view. With the insect firmly secured, the ventral nerve cord was exposed and placed on the recording electrodes. Responses to movement of a small light source in the visual field of one eye were studied. It was soon found that the response to any particular movement could only be elicited repeatedly if a sufficient interval were allowed between successive tests; the preparation became refractory to further stimulation for a period of 5–10 sec. after the first movement was made. Afterwards, test movements were made at 10-sec. intervals, and we report only on movements in a vertical plane.

It was found that consistent responses to movement were obtained until the angular movement of the source, referred to the eye of the insect, was reduced to approximately 1°. For smaller angles, responses were obtained in less than 100 per cent of trials, and for very small angles there was no response at all. Thus the minimum angular movement which gave 100 per cent responses was approximately 1°, which agrees very closely with the angular separation of the ommatidia of the eye measured by independent means.

These results are similar to those found for perception of vertical stripes by *Carausius*[3], and for moving stripes in the honey bee[4] and *Drosophila*[5]. An acuity of perception of movement by the insect eye of the same order as the ommatidial separation thus seems well established. The responses we obtained to smaller movements (down to $\frac{1}{3}$° in some cases) are difficult to explain, if we regard the ommatidium as a single functional unit. We are at present investigating these minimal responses on the assumption that they occur when the light source is moved just across the projected boundary between two ommatidia.

The preparation as a whole offers a ready means of studying a number of visual responses, for example, spectral sensitivity of the eye, reactions to changes of light intensity, extent of visual field and variations in response of different regions of the compound eye.

We think that the biological significance of the impulse discharges described lies in relation to the jumping habit of the insect, the impulses giving an effector response in the muscle of the jumping legs (last thoracic segment). We could find no similar responses in *Carausius*.

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Heterozygosity, Environmental Variation and Heterosis

When a wild strain of *Drosophila melanogaster* is inbred under optimum conditions, the phenotypic variance of body-size is reduced by not much more than 50 per cent[1]. This suggests that nearly half the variance of the original strain was due to the effects of uncontrollable environmental variations within the culture. But highly inbred lines tend to have a much higher variance than crosses between them, so that the environmental variance in such quantitative characters is not constant for all genotypes and tends to be smaller in heterozygotes than homozygotes. This is illustrated in Table 1 for six highly inbred lines and the crosses between them. The lines came from two unrelated wild stocks, Nettlebed and Edinburgh, and include two lines selected for long wings (*LN* and *LE*), two selected for short wings (*SN* and *SE*) and two unselected lines (*UN* and *UE*). Wing-length is closely correlated with body-size, and variance is expressed as squared coefficient of variation, since this measure eliminates most of the effect of differences in absolute size.

Table 1. Phenotypic Variance of Inbred Lines and Crosses. Variance of wing-length in squared coefficients of variation

Strains crossed	Parental average	F_1	
LN × *SN*	1·79	1·37	females only
LE × *SE*	1·44	0·52	males only
UN × *UE*	2·27	1·11	sexes combined
SN × *UN*	2·85	1·88	,,
SE × *UE*	1·78	0·55	,,
SN × *SE*	4·00	2·00	,,
Average	2·35	1·24	

The inbred lines have, on the average, almost double the phenotypic variance of the crosses between them, and the same tendency is shown by crosses involving large, small and unselected lines. There are probably also differences in variance between the different inbred lines; but part of the differences between the parental averages for the six comparisons must be attributed to environmental differences between the experiments in which they were tested.

The relation between heterozygosity and environmental variance has been further analysed by preparing genotypes containing specific combinations of the three major chromosomes from inbred lines *SE* and *UE*, using methods which will be described elsewhere. If these genotypes are grouped according to the numbers of heterozygous pairs of chromosomes they carry, we find that the average variance of wing-length declines progressively with increase of heterozygosity (Table 2), so that the environmental variance of a particular genotype appears to be intimately related to the degree of heterozygosity.

A partial analysis of the *SN* × *UN* cross by the same technique shows the same general trend for size, and in view of the differences in variance between inbred lines and their crosses, it is likely to be a general phenomenon. The same general relationship also appears to hold for rate of egg production, both in comparisons between inbred lines and their crosses, and in comparisons between the specific genotypes of differing heterozygosity referred to above. But problems of scaling make interpretation of these figures difficult, since the heterozygotes tend to have a much greater output than homozygotes. It seems probable that many quantitative characters in different animals and plants will show the same tendency for environmental variability, under given conditions, to decrease as heterozygosity increases. It is not to be expected, of course, that the same rule would hold good when one is dealing with individual genes with large effects.

Table 2. Variance and Heterozygosity in *SE*/*UE* Genotypes

No. of major chromosome pairs heterozygous	No. of genotypes tested	Average variance of wing-length
Females		
0	5	2·54
1	9	2·23
2	5	1·44
3	1	1·20
Males		
0	5	1·64
1	7	1·31
2	2	1·19

Size in *Drosophila* shows the same phenomena of decline under inbreeding and heterosis in crosses between inbred lines as other quantitative characters. This suggests that heterosis, or increased size, vigour, etc., and reduced susceptibility to environmental variations are both manifestations of the same phenomenon of heterozygosity. There may be a general explanation for this relationship: the more heterozygous individuals will carry a greater diversity of alleles, and these are likely to endow them with a greater biochemical versatility in development. This will lead to heterosis, because of the more efficient use of the materials available in the environment, and also to a reduced sensitivity to environmental variations, since there will be more ways of overcoming the obstacles which such variations put in the way of normal development.

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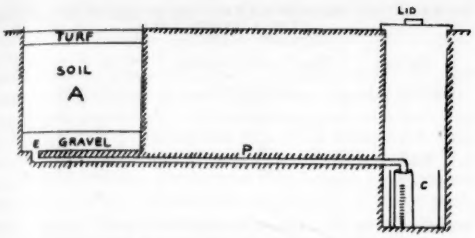
A Simple Apparatus for Measuring Potential Evapotranspiration

The combined process of evaporation from the soil and transpiration from plants is known as 'evapotranspiration'. The amount of moisture so used varies from place to place and depends mainly on climate (especially temperature and precipitation) and the closeness of the vegetative cover. 'Potential evapotranspiration', on the other hand, refers to the amount of moisture which would be utilized if supplies were unlimited and vegetative cover complete. Its value, therefore, alters irrespective of precipitation and vegetation and is a function mainly of length of day and temperature[1].

Potential evapotranspiration can be measured simply and cheaply by an apparatus (see diagram) made of oil drums, some lead piping and a suitably graduated jar. A 44-gallon drum (*A*) is cut down to a height of about 55 cm. From this a right-angled elbow (*E*) is led to a piece of ¾-in. lead piping (*P*) which drains into a container (*C*), where there is a graduated jar into which the overflow drips directly. There should be a protective shaft for this container, which must be covered to stop the rain getting in.



A layer of gravel is put at the bottom of the 'evapotranspirometer' (*A*) and the outlet (*E*) is covered by a small-meshed copper screen. Soil of a light, friable nature, which permits free drainage and water circulation, is placed in the tank (*A*) where, for general purposes, grass should be grown. A suitable procedure is to install the apparatus in a level field of grass so that the sod removed during installation can be replaced in the tank after the soil there has had time to settle. The area immediately surrounding the apparatus should be kept well watered so that the micro-climate above the tank and its surroundings is as nearly similar as possible.

I installed an apparatus of this type in July 1951 at the Johns Hopkins Laboratory of Climatology, Seabrook, New Jersey. It measures potential evapotranspiration by a very simple process. A known amount of water is applied to tank (*A*) and the drainage is collected in the overflow (*C*). Potential evapotranspiration thus equals the amount of water applied plus precipitation, less the amount collected in the overflow. The amount of water applied to the tank and collected in the overflow can be converted easily to inches or millimetres of 'precipitation' as required. This principle is the same as that used for the more elaborate installations already at Seabrook, against which the new apparatus has been tested with satisfactory results. It can be read like a rain-gauge and, if erected at existing climate stations in different parts of the world, would add very little in expense or observational time, since only one reading a day is required. In this way it could be used in many areas to provide an indication of a climatic factor well worth more attention.

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[1] See various articles by C. W. Thornthwaite, especially "An Approach towards a Rational Classification of Climate", *Geog. Rev.*, **38**, No. 1, 55 (Jan. 1948) and "Climate and Moisture Conservation", *Ann. Assoc. Amer. Geog.*, **37**, No. 2, 87 (June 1947).

A New Serological Division of *Staphylococcus aureus* Bacteriophages: Group *G*

The bacteriophages lysing *Staphylococcus aureus* have been divided by Rountree[1] into five serological groups, designated *A*, *B*, *C*, *D* and *F*. Phages of groups *A*, *B* and *F* were isolated from lysogenic staphylococci from human sources.

Three phages have been received in this Laboratory that are not neutralized by anti-sera of any of Rountree's groups. Each of these three phages is neutralized by an anti-serum prepared against one of the three, and this anti-serum fails to neutralize phages of the groups *A*–*F*. We refer to this new serological group as Group *G*.

The three phages are numbered 65, 66 and 68 in our collection. The first two were isolated by Dr. Wallmark of Stockholm using the cross-culture technique of Fisk[2], and are referred to as 155 and 166 by him[3]. The third phage, known as 68, was received from Dr. Wahl of Paris, and had appeared as a variant of one of the phages, 44*A*, used for the routine typing of staphylococci[4].

Like the phages of groups *A*, *B* and *F*, these three phages lyse only coagulase-positive staphylococci; but they differ from these groups in lysing a greater variety of strains. Undiluted filtrates of all three lyse most coagulase-positive staphylococci; at their routine test dilutions the phages lyse about 40 per cent of a mixed group of strains, including strains of all the three major groups defined in routine phage typing and some strains not lysed by any of the typing phages. Because of the number of strains lysed, the group *G* phages are not used for phage-typing in this laboratory.

The plaque-size of these phages is often variable on a single culture; small clear, or indistinct, plaques may be mixed with larger plaques that are often surrounded by a halo. When picked and plated the phages giving these different plaques do not generally breed true.

Phages of group *G* may be readily propagated to high titre on nutrient agar, or in broth. In this respect, and in their wide lytic range, they resemble the phages of serological group *D*.

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Nupserha bicolor Thoms., subsp. *postbrunnea* Breun.: a New Pest on Jute (*Corchorus olitorius* Linn.)

Das[1] recently compiled a list of insect and mite pests of the two cultivated species of jute, namely, *Corchorus capsularis* and *Corchorus olitorius*. A pest, hitherto unrecorded in India, was detected in *olitorius* jute during 1949 on the farm of the Jute Agricultural Research Institute, and was identified by the Commonwealth Institute of Entomology, London, as *Nupserha bicolor* Thoms., subsp. *postbrunnea* Breun. The pest has since been found to be an important one for all the varieties of *C. olitorius*, while the *capsularis* varieties show resistance to it.

The pest has special economic importance, as it causes an immediate loss of a considerable portion of the stem. The ovipositing female cuts two rings around the stem with its sharp mandibles at two different levels, 0·7–2·7 cm. apart, with highest frequency between 1·0–1·4 cm. A slit is cut between the rings down to the pith tissue for oviposition. This causes withering and ultimate death of the apical plant region above the lower ring.

From our observations, it is presumed that the seat of oviposition chosen has a direct relation to the ratio of the length of mandibles of the laying female

and the diameter of the stem. No oviposition has been recorded in stems outside the diameter range of 0·2–0·4 cm.; rings may be cut on stems of diameter up to 0·5 cm., but these do not generally exceed 0·4 per cent of the total. This clearly indicates the role of mandibles in the selection of diameter of stem for oviposition, and consequent susceptibility to damage.

Loss of plant height is therefore regulated by the actual seat of oviposition in the stem within the range of susceptible diameter. Frequencies of occurrence of height classes lost with susceptible diameter classes at the level of the lower ring show that the highest frequency lies in the height range 10–20 cm. and stem diameter 0·26–0·3 cm.

With susceptibility restricted to the apical part of the stem, loss of fibres becomes insignificant with older crops. It has been estimated that, in the young crop, loss of stem may be up to 30·02 per cent; in older crops, it is 6·32 per cent on the average.

Pre-ovipositing operations and feeding on the veins of the leaves by the adults, leaving the softer tissues intact, produce symptoms so specific that they may be taken as a field key for identification.

Crotalaria juncea, C. saltiana, Hibiscus cannabinus, Æschynomene aspera and *Sesbania ægyptiaca* have been recorded as alternative host plants.

Fuller details will be published later. Thanks are due to Dr. B. C. Kundu, director of the Institute, for his helpful suggestions.

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Bacterial Invasion

Let it be assumed that: (*a*) each organism invading a host has a chance λ of reaching a favourable site, and of afterwards undergoing a sequence of events which enable it to proliferate and result in the death (or infection) of the host; (*b*) each organism acts independently; (*c*) c inhaled organisms are necessary to produce the death (or infection) of 0·5 of the total of exposed animals; (*d*) the experimental animal population is large and homogeneous. Then the proportion S of animals remaining uninfected after the intake of n organisms each is given by:

$$S = (1 - \lambda)^n,$$

and by definition $0{\cdot}5 = (1 - \lambda)^c$.

Expressing n in units of c, that is, $n = fc$,

$$S = (1 - \lambda)^{fc} = 0{\cdot}5^f.$$

Where invasion by pathogens is through the respiratory system, these conditions might well apply. The argument is not invalidated by consideration of the case of many organisms grouped in one particle, since once the particle is deposited on a moist surface the cluster usually disintegrates and each organism has an independent subsequent history.

For the purpose of comparison with existing data on experimental respiratory infection available to me, the curve $S = 0{\cdot}5^f$ was plotted on the conventional probit–log dose plane. The curve shows a slight upward concavity, but is almost straight between the ED_{25} and ED_{75} values, having a mean slope of approximately 1·9. Tables 1 and 2 show experimental values of slopes for comparison.

Table 1. Slopes Obtained by Exposure of Animals to Clouds of Anthrax Spores (Ref. 1)

Animal	Size of particle inhaled	Slope $\pm 2\sigma$ range
Guinea pig	Single spore	1·26–2·13–3·0
,,	3·5 μ	1·31–2·44–3·57
,,	4·5 μ	0·59–1·26–1·93
,,	8 μ	1·67–2·54–3·41
,,	12 μ	0·72–1·25–1·78
Monkey	Single spore	1·45–3·19–4·93
,,	12 μ	0·32–1·17–2·02

Table 2. Slopes Obtained by Exposure of Guinea Pigs to Clouds of Single Organisms of the *Brucella* Group (Ref. 2)

Organism	Slope $\pm 2\sigma$ range
Br. suis	0·26–1·17–2·08
,,	1·64–2·86–4·08
,,	1·47–2·61–3·75
,,	1·41–2·54–3·67
Br. melitensis	0·99–1·76–2·53
,,	0·51–1·54–2·57

It will be observed that in twelve of the thirteen results quoted, the slope value of 1·9 given by the theoretical curve lies within the 2σ range of the experimental results.

If the hypothesis outlined be true, it follows that the infection or mortality among a batch of animals exposed to a given bacterial cloud depends upon the total number of organisms deposited in the respiratory tract of the host, and not upon the time taken to deposit them. This, of course, will not be true if the time of exposure is made sufficiently long for immunity processes stimulated by the early depositions of organisms to influence the fate of those deposited later. Thus for a batch of animals exposed to a bacterial cloud, it would be expected that a constant mortality or infectivity would be obtained if the aerosol concentration (C) $\times$ time of exposure (t) = constant.

Results supporting this conclusion have been quoted by Goldberg and Watkins[3] using *Streptococcus zooepidemicus* and *Klebsiella pneumoniæ*, while a value of $C^{(1{\cdot}1 \pm 0{\cdot}06)t}$ = const. has been obtained for *B. anthracis* spores and guinea pigs by workers[1] in this department.

Expressed in its logarithmic form, the equation becomes:

$$\log S = -0{\cdot}301\,f.$$

It is suggested that bacteriologists, particularly in the field of respiratory infection, might consider whether a simple plot of log survival against dose might provide adequate linear representation of their results, as was found to be true for the results the slopes of which are given in Tables 1 and 2.

I am indebted to Dr. D. W. Henderson and Mr. S. Peto for help and advice, and to the Chief Scientist of the Ministry of Supply for permission to publish this communication.

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Wave Velocities in the Outer Part of the Earth's Mantle

HITHERTO, wave velocities V in the earth's interior have been calculated from the travel times t of earthquake waves in shallow shocks computed as a function of the epicentral distances Δ. This procedure fails if at any depth the velocity V decreases with depth at a rate in excess of $dV/dr = V/r$, where r is distance from the centre. In this case a portion of the travel-time curve is formed by the arrival of diffracted waves; if these are misinterpreted as direct waves, incorrect velocities are found not only for the low-velocity layer, but also (with decreasing errors) for all deeper layers. Moreover, discontinuities may be inferred when none actually exists.

In 1914, in a different form, the following equation was developed by S. Mohorovičić[1]: $V = V^* r/R$, where R is radius of the earth, V is velocity at the depth $h = R - r$ of the focus, and V^* is apparent velocity $(d\Delta/dt)$ at the point of inflexion (distance Δ^*) of the travel-time curve for longitudinal (P) or transverse (S) waves in a given shock. Apparently it has not been realized that this equation can be used to calculate the velocities of the two waves at a depth corresponding with the focal depth. Neither the time of origin of the shock nor the distance Δ^* enters the calculations. The focal depth h of the shock must be known, and a sufficient number of reliable time observations at distance from about 500 km. less to 500 km. greater than Δ^* must be available for finding V^*.

About eighty earthquakes were found listed in the International Seismological Summary for which the necessary conditions for application of the method are fulfilled. Most of them occurred in the Japanese area between 1930 and 1940 at depths from 20 km. to 600 km. For years later than 1940 the Summary has not yet been issued. Data for a few shocks in the eastern and central Mediterranean (depths between 100 km. and 300 km.), in Roumania (150± km.) and in the Hindu Kush (250± km.) do not indicate any appreciable regional differences in velocity at the depths involved. Average velocities V (longitudinal) and v (transverse) in km./sec., and values of Poisson's ratio σ at the depths h in km. are as follows:

h	50	100	150	200	250	300	400	500	600
V	8·0	⩽7·8	⩽7·9	8·1	8·3	8·5	9·0	9·6	10·2
v	4·45	⩽4·4	⩽4·35	⩽4·4	4·45	4·6	4·95	5·3	5·65
σ	0·26	0·27	0·27	0·28	0·29	0·29	0·29	0·29	0·29

These new values agree well with those which had been found by application of the older method to times of travel of shallow shocks; but they bring out much more prominently the low-velocity layer at depths near 100 km. This had been indicated previously by observations of amplitudes, especially 'shadow zones'[2], at epicentral distances of about 1,000 km. The new velocity data do not indicate any discontinuity within the range of depth given above. A sudden increase in velocity at a depth of about 400 km. has been assumed by some to explain the so-called 20°-discontinuity in the travel-time curve. However, this discontinuity is a consequence of 'ray optics' produced by the low-velocity layer. The actual velocities in the low-velocity layer may be somewhat smaller than those given in the table, since the resulting decreases in V and v possibly exceed the critical rates of 0·13 and 0·07 km./sec. per 100 km. respectively. Local temperature or other relatively small differences at the depths involved may result in a decrease of velocity less than the critical rate in one area and in excess of it in another. Thus P or S or both may show 'shadow zones' of different extent (including zero) depending on the region, and even noticeable differences in time of travel. This could explain the appreciable local differences in the observed amplitudes of P and S in recorded shocks of a given magnitude at epicentral distances between 500 km. and 2,000 km., even when the velocities at the depths involved are practically the same in all such regions.

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Band Spectrum of AsH

IN a letter to *Nature*, Kimball and Bates[1] stated that they have succeeded in obtaining the band spectrum of AsH. The spectrum was excited in a carbon arc run in an atmosphere of hydrogen. The lower electrode formed the cathode of the arc and contained the arsenic. Two bands with origins at 32,380·2 cm.$^{-1}$ and 31,639·9 cm.$^{-1}$ were observed and attributed to AsH. The lines of the band at 32,380·2 cm.$^{-1}$ are represented by the formula

$$\gamma = 32{,}380{\cdot}18 - 11{\cdot}186\,m - 4{\cdot}47\,m^2 + 0{\cdot}0485\,m^3 + 0{\cdot}01027\,m^4.$$

We have tried to photograph the bands mentioned by Kimball and Bates but without success, although a large range of excitation conditions has been used.

It seems probable that Kimball and Bates have been confused by the P and R branches of the $^2\Sigma - {}^2\Pi$ system of CH. Using the frequencies of the lines for the R_1 and R_2 branches of the (0,0) CH band, as listed by Heimer[2], a close fit of the alternate lines is obtained with the lines calculated from the formula given by Kimball and Bates. This is illustrated in the table for a number of lines.

COMPARISON OF THE AsH LINES WITH ALTERNATE CH LINES

R branch of AsH	R_2 branch of CH	P branch of AsH	R_1 branch of CH
32,364·6	32,366·4	32,386·9	32,388·5
340·5	340·6	384·4	384·2
308·5	307·6	373·0	377·1
269·6	268·4	352·9	355·7
224·9	224·6	324·6	325·7
175·8	177·2	289·1	289·1
124·0	126·6	247·3	247·5
071·3	073·7	200·6	201·4
019·9	019·3	150·5	152·1

The other AsH band mentioned by Kimball and Bates was probably confused with the P branches of the 0,0 band of CH and the Q branch of the 1,1 band. The 1,1 band of CH forms a Q head at the approximate frequency of the AsH head mentioned by Kimball and Bates.

Pearse and Gaydon[3] have directed attention to the fact that the band attributed to As_2 by Kimball and Bates is probably identical with the Q branches of the 0,0 CH band.

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Pretoria. Feb. 29.

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Relation between Activation Energy and Frequency Factor

It has been frequently observed that in some series of kindred reactions the activation energy of the process appears to be functionally related to the respective frequency factor A. For example, when one investigates a reaction taking place in various solvents, one often finds that E (the activation energy) and A change in the same direction. Such behaviour might indicate that the variation in the nature of the solvent affects the degree of solvation of the transition state, and consequently the activation energy and the entropy of activation (that is, A) in the same direction.

It appears that such relations do not hold for series of kindred unimolecular reactions taking place in the gaseous phase. For example, it has been pointed out[1] that the unimolecular dissociation processes of the type:

$$R.CH_3 \rightarrow R.CH_2\cdot + H, \quad RCH_3 = \text{toluene, } m\text{-xylene, } p\text{-xylene and } o\text{-xylene,}$$

have a constant frequency factor (apart from the statistical factor of 2 for the xylenes). However, since the activation energies for these processes vary by about 3 kcal./mole only, and the experimental errors involved in their determinations might be as large as ± 2 kcal./mole, this evidence is not very convincing. We have, therefore, been searching for a series of kindred reactions in which activation energies vary over a wide range in order to be able to draw some definite conclusions about the behaviour of the frequency factors.

The series of unimolecular dissociation processes of the type

$$R.Br \rightarrow R\cdot + Br$$

seems to be suitable for such studies. Activation energies were determined for the following decompositions; allyl-bromide, trichlorobromo-methane, benzyl-bromide, benzoyl-bromide, methyl-bromide and phenyl-bromide. All these reactions were studied over a sufficiently wide range of temperatures to yield a reasonably accurate determination of E, and the results, computed by the least square method, are summarized in the accompanying table. (The frequency factor for CH_2Br decomposition has been computed by a different method; see, for details, ref. 5.)

Inspection of the table reveals that the frequency factors seem to be approximately constant for a variation in the activation energies of 24 kcal./mole. The approximate constancy of the frequency factors should be contrasted with variations in the rate constants, computed for one temperature, which vary by more than 10^5. This evidence supports strongly the claim that for a series of kindred unimolecular dissociation processes, in which one bond only is ruptured and the molecule is split into a radical and a free atom, the frequency factor is a constant, depending on the nature of the ruptured bond and independent of the structure of the molecule. This conclusion has been drawn previously[2], but the experimental evidence was less satisfactory[3].

R–Br	Ref.	E kcal./mole	$A \times 10^{-13}$ sec.$^{-1}$	$k_{900°}$ sec.$^{-1}$
$CH_2:CH.CH_2$–Br	4	47·5	0·5	16·0
Cl_3C–Br	5	49	2	30·0
$C_6H_5.CH_2$–Br	4	50·5	1	6·0
$C_6H_5.CO.$–Br	6	57·0	5	0·60
CH_3–Br	5	~67	~2	0·001
C_6H_5–Br	7	70·9	2	0·00016
$\alpha.C_{10}H_7$–Br		70·9	3·5	0·00028

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The Born Approximation in Electron Diffraction

The Born approximation for the electron wave scattered by an atom has been universally employed for the interpretation of electron diffraction experiments directed toward the determination of molecular or crystal structure. There is some justification for this. Quantitative measurements of diffraction intensities performed to test the applicability of the approximation for electrons of the energies usually used in structure work have, on the whole, been regarded as satisfactory verifications. In structure work itself—in the work on gas molecules, for example—the considerable success resulting from its use has led to the feeling that even in the presence of heavy atoms there might not be serious error. There has perhaps been the implicit faith that whatever theoretical refinements were lacking would at least not alter substantially the structures to be derived. We have found, however, that there is a phase shift on scattering, not given by the first Born approximation (this is the familiar Born approximation, the first term of a power-series expansion in the parameter $\alpha = -Ze^2/h\nu$), which is approximately proportional to atomic number, depends on angle of scattering, and may become large and important. The suggestion of the existence of this phase shift arose from the cases of uranium hexafluoride (UF_6) and some other gas molecules.

Interpretations of electron diffraction data from uranium fluoride have uniformly led[1] to the conclusion that the U—F bond-lengths are not all equal; but other physical data (spectra, entropy, dipole moment) have all been interpreted[2] as demanding the regular octahedral structure. Altogether, although various arguments have been made to support the possibility of unequal bond-lengths, it would seem that the greater weight of the evidence is against it. The electron diffraction conclusions for a number of other molecules MX_n are strikingly similar, and show no obvious relation to known structural chemistry. On the contrary, they all split the bonds into essentially two equal

groups differing in bond-length by amounts approximately proportional to the differences of atomic numbers. (The pattern observed for the heavy molecule I_2 is normal.) This simple behaviour suggests an inadequacy of the scattering theory rather than the existence of real structural asymmetries. The most likely sources of difficulty are the neglect of multiple scattering (by different atoms) and the inaccuracies of the Born approximation for atomic scattering. Multiple scattering clearly cannot produce an effect depending strongly on difference of atomic numbers, but interference between corrections to the atomic scattering can.

We therefore neglect all such effects as double scattering and valence distortion, and assume that the scattering by a molecule in practice still may be represented by a superposition of waves $f_j(\vartheta)e^{ikr}/r$ scattered by the separate atoms. It is important that the amplitudes $f_j(\vartheta)$ may be complex, although the first Born approximation alleges them to be real. With $f_j(\vartheta)$ written then as $|f_j(\vartheta)|\exp(i\eta_j(\vartheta))$, the scattered intensity is proportional to

$$\sum_{i,j} |f_i(\vartheta)||f_j(\vartheta)| \cos\{\eta_i(\vartheta) - \eta_j(\vartheta)\} \frac{\sin sr_{ij}}{sr_{ij}},$$

where s is the magnitude $|\mathbf{k} - \mathbf{k}'|$ of the difference of initial and final propagation vectors and r_{ij} is the separation of the atoms i and j. If the amplitudes are real, the terms of this expression contributed by a split pair of distances $r_{ij} = r_0 - \lambda$ and $r_{ij'} = r_0 + \lambda$, with like atoms j and j', become

$$2|f_i(\vartheta)||f_j(\vartheta)| \cos s\delta \frac{\sin sr_0}{sr_0}.$$

Since this is just the result for complex amplitudes and $r_{ij} = r_{ij'} = r_0$, if $|\eta_i(\vartheta) - \eta_j(\vartheta)|$ is proportional to s, the features of diffraction patterns which with the Born approximation lead to such splits may still be interpreted in terms of symmetrical structures. (The intensity is evidently highly sensitive to the phase difference only where the phase difference is close to an odd multiple of $\pi/2$, and in the absence of accurate intensity measurements it is only the corresponding behaviour that can be regarded as well determined. Any moderately smooth and not too great deviations of $|\eta_i(\vartheta) - \eta_j(\vartheta)|$ from proportionality to s, at other angles, and of the $|f_i(\vartheta)|$ from the Born approximation values, at any angle, could well remain unnoticed in gas diffraction work.)

Preliminary estimates of the phase shifts $\eta(\vartheta)$ have been made by evaluating the second Born approximation, a procedure which may be justified by noting that for screening distances large compared with the wave-length the third Born approximation makes a rather small contribution to the phase. The absolute value $|f(\vartheta)|$ of the scattered amplitude cannot be very seriously in error since in the limit (pure coulomb scattering) its value is exactly correct. The asymptotic phase shift is essentially divergent, however, and shows how screening, as one might expect, has a most important role. In particular, for exponential screening ($V(r) = -(Ze^2/r)\exp(-r/a)$), the phase shift for forward scattering has the value $\eta(0) = -\alpha/2$; for large angles it increases as $-2s\log(sa)$, where a is the screening distance.

The accompanying table illustrates the resulting agreement. The 'observed' distance splits are the values obtained from the observed diffraction patterns with the assumption of no phase shift; the calculated values are approximately the ones which would follow from this interpretation even in the absence of actual distance splits if the phase shift were that given by the second Born approximation for exponential screening. The agreement is remarkable, especially because neither the conventional values $a_0/Z^{1/3}$ used for the screening distances (a_0 is the Bohr radius for hydrogen) nor the approximation of exponential screening itself could be expected to be quantitatively satisfactory. We may add that, to the best of our knowledge, there are no adequately reported gas studies which disagree with the phase shift; those involving heavy atoms and apparently providing support for the Born approximation, for example, are all based on data at s values less than would give the critical relative phase shift $\pi/2$. For crystal diffraction, on the other hand, the phase shift is presumably often important even when not large. We have examined only the intensity anomalies of fluorite[2], cuprous chloride[3] and zinc oxide[4]. Fluorite and cuprous chloride appear to be well explained by the phase shifts; zinc oxide is not.

Molecule	Distance	Apparent split (A.) Observed	Calculated (*a*)
UF_6	U—F	0·30(*b*)	0·28
OsO_4	Os—O	0·23(*c*)	0·24
$W(CO)_6$	W—C	0·24(*c*)	0·24
	W···O	0·23	0·23
WF_6	W—F	0·23(*b*)	0·22
WCl_6	W—Cl	~0·18(*e*)	0·18
IF_5	I—F	0·18(*f*)	0·15
$Mo(CO)_6$	Mo—C	0·13(*c*),(*d*)	0·13
	Mo···O	0·13	0·12
MoF_6	Mo—F	0·14(*b*)	0·12

(*a*) For $\lambda \sim 0{\cdot}06$ A., with the relativistic value of α.
(*b*) UF_6: Bauer, S. H., and Bastiansen, O., ref. 1. WF_6 and $Mo.F_6$: Bastiansen, O., unpublished work in these laboratories.
(*c*) Sheehan, jun., W. F., thesis, California Institute of Technology (1952).
(*d*) Mo—C and Mo···O splits assumed equal.
(*e*) From re-examination of the photographs described by Spurr, R. A., thesis, California Institute of Technology (1942).
(*f*) Results of Rogers, M. T., thesis, California Institute of Technology (1941), adjusted to a symmetrical (2– /2 : 2–/2) split. Spectroscopic evidence (Lord, R. C., Lynch, jun., M. A., Schumb, W. C., and Slowinski, jun., E. J., *J. Amer. Chem. Soc.*, **72**, 522 (1950)) indicates C_{4v} symmetry, and the actual I—F lengths may well not all be equal.

Note added July 17. The difference in intensity of (331) and ($33\bar{1}$) reflexions from zincblende as reported by Miyake and Uyeda[5] corresponds in sign and possibly in magnitude to the present phase shifts, but the relative importance of these phase shifts and of the dynamic effect discussed by Kohra, Uyeda and Miyake[6] is not clear.

VERNER SCHOMAKER
Gates and Crellin Laboratories of Chemistry,
ROY GLAUBER
Norman Bridge Laboratory of Physics,
California Institute of Technology,
Pasadena, California.
May 1.

[1] Braune, H., and Pinnow, P., *Z. phys. Chem.*, B, **35**, 239 (1937). Bauer, S. H., *J. Chem. Phys.*, **18**, 27 (1950). The observations have been checked in these laboratories by Dr. O. Bastiansen.
[2] See especially Bigeleisen, J., Mayer, M. G., Stevenson, P. C., and Turkevich, J., *J. Chem. Phys.*, **16**, 442 (1948) and Burke, T. G., Smith, D. F., and Nielsen, A. H., *J. Chem. Phys.*, **20**, 447 (1952).
[3] Germer, L. H., *Phys. Rev.*, **56**, 58 (1939).
[4] Yearian, H. J., *Phys. Rev.*, **48**, 631 (1935).
[5] *Acta Cryst.*, **3**, 314 (1950).
[6] *Acta Cryst.*, **3**, 479 (1950).

FORTHCOMING EVENT

Friday, August 22

ROYAL ANTHROPOLOGICAL INSTITUTE (at the University Arts School, Bene't Street, Cambridge), at 5 p.m.—Prof. Kaj Birket-Smith: "The History of Ethnology in Denmark" (Huxley Memorial Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST (Senior Scientific Assistant grade) in the Central Laboratory Service, Chiswick, with responsibility for section dealing with paints and surface protection—The Staff Officer (F/EV.211), London Transport, 55 Broadway, London, S.W.1 (August 23).

CHIEF OFFICER (with executive ability and appropriate qualifications in chemistry) FOR RIVER POLLUTION—The Clerk to the Great Ouse River Board, Elmhurst, Brooklands Avenue, Cambridge (August 23).

LECTURER IN THE DEPARTMENT OF CIVIL AND MUNICIPAL ENGINEERING—The Secretary, University College, Gower Street, London, W.C.1 (August 23).

POSTS in connexion with the construction and development of a linear accelerator in Cambridge—The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (August 23).

SENIOR ASSISTANT (Scientific) (temporary, with experience in histology, surgical technique and handling of farm animals) for experimental work—Dr. J. S. Perry, c/o Agricultural Research Council Field Station, Compton, Newbury, Berks (August 23).

INSTRUMENT ENGINEER (with a University degree, H.N. certificate in electrical engineering, or equivalent qualification) in the Research Laboratories at Leatherhead—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting Ref. AE/269 (August 25).

SENIOR LECTURERS and LECTURERS IN HOME SCIENCE (food and experimental cookery, foods and nutrition, and home management), New South Wales Department of Technical Education—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (August 25).

LEADERS OF RESEARCH SECTIONS at the Central Research Establishment No. 2, at Isleworth, Middx.: GENERAL METALLURGIST with sound practical experience and theoretical background (Ref. TT/513), and a QUALIFIED ENGINEER with research experience to lead section engaged in work on mechanical engineering problems of the industry (Ref. TT/514)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (August 30).

LECTURER, and an ASSISTANT, IN BOTANY—The Assistant Secretary of University Court, The University, Glasgow (August 30).

ASSISTANT BIOCHEMIST (with a University degree, or equivalent; a knowledge of physiology would be an advantage)—The Pathologist, Group Pathological Laboratory, Lakin Road, Warwick (August 31).

VETERINARY SURGEONS (preferably with the dual qualification of M.R.C.V.S. and B.Sc. (Vet.Sc.)) in the Field and Research branches of the Department of Veterinary Services—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (August 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS (preferably with interest in applied mathematics)—The Secretary, University College, Gower Street, London, W.C.1 (September 1).

JUNIOR LECTURER or LECTURER (with an honours degree in botany, zoology or biology) IN THE DEPARTMENT OF BIOLOGY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (September 1).

RESEARCH POST IN THE DEPARTMENT OF METALLURGY (applicant must possess an honours degree in metallurgy, preferably with at least one year's research experience, and will be expected to undertake work on age-hardening phenomena, and possibly later, to lead a team of workers)—The Registrar, The University, Liverpool (September 6).

SENIOR RESEARCH OFFICER for investigations into plant nutrition and biological problems, with particular reference to the cultivation of fruit trees, including citrus, in the Murrumbidgee Irrigation Area (Ref. No. 3940), and a SENIOR RESEARCH OFFICER (Chemist) to conduct research into various chemical aspects of plant growth and soil problems on the Murrumbidgee Irrigation Area (Ref. No. 3941)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 6).

LECTURER IN DAIRYING (graduate, preferably with experience in the dairying industry)—The Registrar, The University, Reading (September 13).

LECTURER (with special interests in some branch of electrochemistry) IN CHEMISTRY—The Assistant Secretary of University Court, The University, Glasgow (September 15).

LECTURER IN FORESTRY (with a University degree, preferably in forestry, and practical experience of British forestry)—The Secretary, The University, Edinburgh (September 15).

LECTURER (honours graduate with appropriate qualifications and experience) in SOCIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

SENIOR LECTURER IN CHEMICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

ASSISTANT LECTURER (graduate in chemical engineering, physics or mathematics) IN CHEMICAL ENGINEERING, to undertake work in hydrodynamic problems of chemical engineering—The Registrar, College of Technology, Manchester 1 (September 17).

SENIOR LECTURER IN MEDICAL BACTERIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 20).

VETERINARY PHYSIOLOGIST at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 20).

ASSISTANT LECTURER IN BOTANY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 30).

MACKINNON RESEARCH STUDENTSHIP for research in the physical sciences, including chemistry, geophysics, astronomy and engineering sciences—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 10).

DIRECTOR (graduate of a British university and Fellow of the Museums' Association, or equivalent qualifications)—The Director, City Art Gallery, Bristol 8 (October 22).

ASSISTANT (Grade A) IN PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT PSYCHOLOGIST in the Hospital and associated psychiatric clinics for adults and children—The Medical Superintendent, South Warwickshire Hospital Group, Central Hospital, Warwick.

ASSISTANT RESEARCH CHEMIST (organic) IN THE HOP RESEARCH DEPARTMENT—The Registrar, Wye College, Wye, Ashford, Kent.

CHEMIST to assist in laboratory dealing with members' day-to-day production problems—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

CHEMIST for research on nutritional aspects of trace elements, in particular iodine—The Director, Laboratory of Human Nutrition, Churchill Hospital, Oxford.

ELECTRICAL ENGINEER (Senior Experimental Officer grade) to work in a team engaged on the development of servo-components (Ref. D.310/52A); and an ELECTRICAL or MECHANICAL ENGINEER or PHYSICIST (Experimental Officer grade) for work on problems connected with either the generation and distribution of electrical power in aircraft or electro-technology research in the design and development of aeronautical equipment (Ref. D.311/52A); at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

ENGINEER at a Ministry of Supply establishment in Hampshire, to design and test military engineering equipment, including bridges and other structures, motor-boats and mechanical devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E.331/51A.

GRADUATE (male) IN CHEMISTRY, PHYSICS or ENGINEERING, with industrial experience, for the speedy assessment and solution of current problems in industrial packaging (ability to write reports for the layman is essential)—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. DPTO.

INTELLIGENCE ASSISTANT (science graduate), competent in abstracting, indexing and technical translation work (German and, if possible, Russian or Dutch) (Ref. A.20); and an EDITORIAL ASSISTANT (woman graduate, preferably in science) for preparing publications (Ref. A.21)—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting the appropriate Ref. No.

LECTURER (with a University degree in physics) IN THE DEPARTMENT OF APPLIED PHYSICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

MINING GEOLOGIST (with B.Sc. degree with honours in mining geology) in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27079/40.

PETROLEUM CHEMISTS (with a degree in chemistry, chemical engineering or metallurgy) for short Service commissions in the Royal Army Service Corps—The War Office (AG8/CH1), Stanmore, Middx.

SENIOR LECTURER IN BIOLOGY in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

STAFF TUTOR IN PHILOSOPHY—The Director of Extra-Mural Studies, The University, Edmund Street, Birmingham 3.

STATISTICIAN (Scientific Officer or Senior Scientific Officer grade) to work on problems and methods in genetics and biological experimentation—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

International Committee for Bird Preservation: British Section. Annual Report for 1951. Pp. 48+4 plates. (London: International Committee for Bird Preservation, c/o British Museum (Natural History), 1952.) 2*s.* [195

National Smoke Abatement Society. Year Book 1952. Pp. 44. (London: National Smoke Abatement Society, 1952.) 1*s.* [195

Other Countries

Southern Rhodesia. Rainfall Handbook Supplement No. 2: Totals of Monthly and Annual Rainfall for Stations in the Northern Area. Pp. N. 59. 2*s.* 6*d.* Rainfall Handbook Supplement Nos. 3, 4 and 5: Totals of Monthly and Annual Rainfall for Stations in the Southern, Western and Central Areas. Pp. S. 26+W. 23+C. 27. 2*s.* 6*d.* (Salisbury: Government Printing and Stationery Department, 1952.) [195

Geological Survey of British Guiana. Bulletin No. 22: i. The Roraima Formation in British Guiana, by P. H. A. Martin-Kaye; ii. The Roraima Formation in the Neighbourhood of the Kamarang and Upper Ekereku Rivers, by P. H. A. Martin-Kaye. Pp. v+50. (Georgetown: Government Printer, 1952.) 1 dollar, 4*s.* 3*d.* [195